

ROMANCE IN ARITHMETIC

A HISTORY OF OUR CURRENCY
WEIGHTS AND MEASURES
AND CALENDAR

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P R E F A C E

THIS is an attempt to meet a need which has been felt in my work both in schools and training colleges. When children are learning to use our systems of money, and weights and measures, there is much information, topical and historical, of value and interest to them which can be imparted by their teacher or acquired by the pupils. For the former there is nothing between the scanty references in some books on methods of teaching Arithmetic and the standard books of reference, usually of greater difficulty and detail than is desired, and all too frequently unobtainable. For the latter purpose the few popular books dealing with these topics, such as Miss S. Cunningham's *The Story of Arithmetic* or Sir John Lubbock's *A Short History of Coins and Currency*, have been out of print for many years and were, in any case, addressed to adults rather than to children.

A certain historical background is necessary for the understanding and appreciation of the social significance of the development of our measures, but this has been made as simple as possible. I hope that the book will not only be of interest to younger children when learning their tables of weights and measures but that it will serve as a source book for older pupils studying certain aspects of social history. It is also envisaged that it may act as a stimulus to further exploration and create greater awareness of the relationship of mathematics to modern civilisation.

Often, that part of the acquisition of mathematical knowledge known as 'Weights and Measures' degener-

ates in unskilful hands into the memorising of facts and the performing of complicated arithmetical operations; to the students in training colleges and to experienced teachers who wish to make Arithmetic real and vital, I hope this account of the origins and history of the standards in common use will prove of service.

Sometimes students have expressed to me the belief that some unknown tyrannical mathematicians were responsible for their struggles with the numbers 1,760 and 4,840; this book should not only disprove such ideas, but should help them, and the many other adults who found Arithmetic dull at school, to realise more fully that 'mathematics is one of the main lines which the creative spirit of man has followed in its development'. It should also help them, as I trust the younger generation may be helped, to judge fairly and with sympathy between those who would abolish forthwith all our customary measures in favour of theoretically superior systems, and those to whom the thought of accommodating themselves to any such changes is fraught with fear and conservative repugnance.

In conclusion, I must acknowledge my debt to the many authors of books and articles of which use has been made; to the Smithsonian Institute for two photographs from the 10th *Annual Report of the Bureau of American Ethnology* which appear on Plates XI and XII; to the Ford Motor Company Ltd. for the six pictures from their folder *History of Measurement* which are reproduced as Plates VI and VII; and especially to Dr. James Walker, Assistant Keeper of the Department of Coins and Medals at the British Museum, for his advice and for his kindness in reading the manuscript of the first part of this work.

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PART I
MEASURES OF VALUE

Chapter I

PRIMITIVE MEASURES OF VALUE

*'If you haven't got a penny, a halfpenny will do.
If you haven't got a halfpenny, God help you.'*

So runs the old rhyme, and most of us would agree heartily with the last line; we feel uncomfortable if we go out of doors, even for a short time, without some money on our persons. Yet there are parts of the world where money is of little use. In Indonesia recently a native brought two of his daughters to pay an Englishman for a shirt which had taken his fancy, and in West Pakistan a shoemaker will agree to repair a family's shoes for a season in return for a weekly supply of grain.

And the great civilisations of ancient Egypt, Mesopotamia, and India rose to high levels of culture and great commercial prosperity without coinage. In Babylon there was even an elaborate system of lending, and paying interest on the loans; the interest, like the principal, consisting of livestock or bags of grain.

A writer describing ancient Egypt says that in the wall-paintings on tombs and temples 'we see the cobbler offering a pair of sandals as payment for a cake, or the carpenter's wife giving the fisherman a little wooden box to pay for the fish'.¹ And when we look at Leighton's well-known picture of the Phœnicians bartering cloth for tin with the Ancient Britons, we see the Phœnicians doing so not because the Britons were savages but because this was the Phœnicians' normal method of business.

¹ J. H. Breasted. *A Survey of the Ancient World*, p. 36. Ginn & Co. 1919.

But when 'barter agreements' are made between nations at the present day, as when Norway supplies tinned sild to Britain in exchange for motor cars, the quantities that make a fair exchange are calculated in terms of one standard commodity—gold.

The disadvantages of simple barter are obvious, the cobbler's sandals may not be the right size for the baker's feet, and the fisherman may say he has plenty of wooden boxes at home already. Certain things, however, will be generally acceptable—things which everyone needs or desires; for if the receiver does not want them himself, he knows he can exchange them again for something else. So such objects as axes or blankets, fish-hooks in fishing communities, and skins in hunting tribes are, at a very early stage in the history of every race, regarded as of special use for payment and in terms of these all other things are given their value.

Several objects may be used thus, at the same time; a 'money' table of Cochin China, for instance, runs—

40 hoes	= 1 earthenware jar
7 jars	= 1 buffalo
6 buffaloes	= 1 slave.

Wherever oxen and sheep are tended, these are used as units, and our word 'pecuniary' comes from the Latin 'pecus', a herd, while 'fee' comes from the Anglo-Saxon 'feoh', an ox, and 'capital' from 'capita', a head (of cattle).

Not only in early times did this sort of thing happen; in the seventeenth century tobacco, the staple crop, was almost the only currency in the southern states of America, and when the Virginia Company imported women from England to marry the many bachelor settlers in that colony, they fixed the price of a wife at

100 pounds of tobacco. And during World War II, in prisoner-of-war camps, when prisoners wanted to swap contents of Red Cross parcels, other things were usually valued in cigarettes, and more or less standard charges were made; e.g., a tin of jam would be priced at twenty-five cigarettes and would be exchanged for a tin of condensed milk at forty cigarettes, with fifteen cigarettes given as change.

Other things would be generally acceptable in bartering, not from their usefulness, but as adornment; and shells, feathers, beads and other ornaments have been the favourite medium with many tribes, and in terms of them, other things were valued. The early settlers in New England found the Red Indians using 'wampum' (beads strung together in definite lengths) and adopted it as a legal currency which was in use as small change till the beginning of the eighteenth century (Plate I).

Some of these standards of exchange suffer from serious defects. Skins, for instance, are not uniform in size or quality, and one cow is a better milker than another; until recently, in Uganda, where goats were still used as money, the duties of one official included being called in to decide, in case of dispute, whether a goat was too old or scraggy to be legal tender. Live currency, too, cannot be used as change unless the animal is killed and the joints used as smaller coins.

There is, too, the difficulty of transport; with live currency a buyer must drive or cart his 'money' towards the seller of the goods he wants, and the sphere of his possible trading is strictly limited. The extreme instance of difficult movement is found on the South Sea island of Yap where the 'coins' are stone discs up to twelve feet in diameter and weighing hundreds of pounds. They

stand in front of huts as evidence to passers-by that the dweller therein was wealthy enough to hire the labour for quarrying them in a distant island and for transportation by canoe, but can serve no other purpose.

On the other hand, with very small standards such as corn, an enormous bulk is required to purchase expensive commodities. Carts, granaries and stables are necessary where we use the modest purse, with a very hampering effect on commerce. High value for small bulk is necessary if trade is to be brisk and far-reaching.

The medium should also be durable, capable of being passed from hand to hand, or stored, without deterioration. Fish as currency, unless well cured, fail signally in the latter qualification. Salt as a medium of exchange has given us our word 'salary', from Latin 'salarium', salt. Bars and little bags of it were used in parts of Ethiopia and it was considered courteous on meeting a friend to offer him a lick of one of your 'coins'. 'Politeness costs nothing' cannot be an Ethiopian proverb, but to speak of 'money melting' was literally true when it rained.

Metals satisfy the requirements of currency best of all. They can be refined and made uniform in quality so that one piece is as good as any other, they are easily cut up for small payments, do not deteriorate by keeping, and in time of danger can be easily buried and hidden. Almost all kinds of metals have been used at some time or other in the world's history, but the baser ones, though acceptable because they can be made into domestic utensils or farm implements by the receiver, involve the transport of heavy loads if used for big purchases. Gold and silver are scarce enough to have a high value compared with objects in everyday use and are universally prized for their intrinsic beauty.

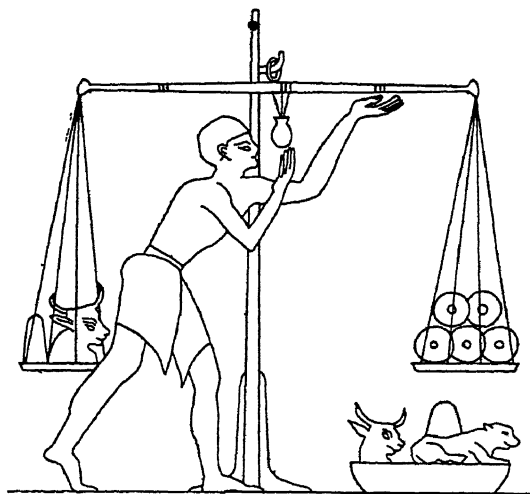


Fig. 1.—Weighing gold rings in Egypt by means of bull-shaped weights (see Part II, p. 67).

So metals came to take the place of the other standards, at first in the form of blocks which were weighed and cut up as required. There are many references in old writings to this state of affairs. When Joseph's brethren had come to Egypt to buy corn, he mystified them by ordering 'every man's money to be restored into his sack',¹ and this money consisted of lumps of metal, not coins; Naaman, after being cured of his leprosy, 'bound two talents of silver in two bags and laid them upon two of his servants'² as a present, and these were evidently of the same nature.

Weighing in a balance takes time, so the next step was to make the blocks into definite sizes. The Assyrians had lumps of silver of standard weights which passed from hand to hand and the Egyptians had heavy rings of gold³

¹ Genesis xlii, 25.

² 2 Kings v, 23.

³ See Fig. 1.

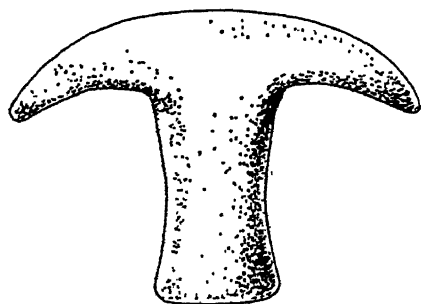


Fig. 2.—Money in the shape of a chopping knife (Aztec—Central America).

and copper which they used for large transactions. In some parts of the world, a certain weight of metal was shaped into the form of some object which it was sufficient to purchase; the Chinese had money in the shape of knives, spades, and shirts, and recent exca-

vations in Crete have brought to light ingots in the shape of hides stretched to dry, and so on.

Sometimes a jeweller would be given a definite weight of metal to make up into an ornament, as in the story of the goldsmith who tried to defraud King Hiero of Syracuse by using base metal covered with gold instead of the pure gold he had been given to make a crown. As he made the finished crown weigh the same as the gold he received he could not be convicted until the great scientist Archimedes suggested dropping the crown and the same weight of gold into two buckets full of water and measuring how much water overflowed from each. As the base metal was lighter (bulk for bulk) than gold, the same weight took up more space and so its presence was detected by a bigger overflow of water.

The gold collars and armlets worn by Scandinavian and Irish tribes, of which the British Museum has many beautiful examples, are of such uniform weight that it seems likely that they did duty as currency as well as ornament. In Genesis too, we read of the jewellery Abraham's servant gave to Rebekah when she drew

water from the well for him and his camels—‘a golden ring of half a shekel weight and two bracelets for her hands of ten shekels weight of gold’,¹ evidently a similar idea (Plate I).

The final innovation was to stamp the pieces of metal—sometimes with the figure of the animal or object whose purchase price they were, or else as a guarantee that the metal was of a certain purity or of a certain weight. Assaying, i.e., testing the purity of metal, is a lengthy and difficult process, and a merchant, after assaying a bar, would stamp it with his mark so that if it came back to him in course of trade he need not do so again, and other merchants would save themselves the trouble of doing so by accepting his mark as reliable. So the earliest marks rather resemble the hall-marks on our silverware.

But to have the metal in a series of definite weights was already a familiar idea and to combine the two was the final step to making a coin—a piece of metal stamped as being of a definite quality and of a certain weight.

The first coins in the Western world were, according to tradition, made about 700 B.C. in Lydia, a great centre of trade in Asia Minor, and the mines from which the metal came were those which later made King Cræsus so rich as to become a legend (Plate II, (i)).

Other cities in Asia Minor and Greece copied the idea and carried it in their trading to all the countries bordering the Mediterranean, and gradually it spread all over Europe (Plate II, (ii)).

In the East the Chinese were the first nation to use coins and they probably invented them about the same time as the Lydians.

But for long centuries after coins were in use men

¹ Genesis **xxiv**, 22.

continued to think of them in terms of weight (Plate V). Many coin names were originally the names of weights. The talent and ducat were both the names of weights before they became coins; the word 'talent' later acquiring quite a different meaning from either of its old ones through Christ's parable. Our pound is derived from the Latin 'pondus', a weight, which has also given us the words 'ponderous' and 'preponderating', and though we still use pound in the double sense it began as a weight. For instance, William I made a daily allowance of a pound-weight of silver to Edgar Atheling to live on at his court after the Conquest. The shilling, too, was used to express weight. The law known as the Assize of Bread and Ale, which is probably one made by Edward I, states: 'When a quarter of wheat is sold for twelve shillings, then wastel bread of a farthing, white and well baked, shall weigh eleven shillings and fourpence,' showing the shilling used with its two different meanings in the same sentence. And the pennyweight survives to the present day in our troy table, still used for precious stones and metals.

Chapter II

ENGLISH COINS FROM THE EARLIEST DAYS TO STUART TIMES

THE earliest British coins that have been found date from the first century before Christ; they have horses and heads of men with streaming hair represented on them and resemble those of the tribes of Gaul across the Channel. The earliest ones with an inscription, so that we are able to date them accurately, have the name of Tasciovanus who reigned 30 B.C.—A.D. 5. He was the father of Cymbeline, the hero of one of Shakespeare's plays, and of his coins also there are plenty in existence.

During the Roman occupation of Britain, the inhabitants were made to use Roman coins, because the Romans thought the use of the same coinage was helpful in making distant provinces feel part of the Roman Empire. But they set up mints where the coins could be made in the provinces instead of at Rome, and we have left coins marked with the Roman names of London, Colchester, etc., which show that there were mints in these towns in Roman days.

We still use abbreviations that arose in those early times.

ℓ is the first letter of 'libra', the Latin for 'a weight' and also 'a balance', and was used as an abbreviation for both weight-pound and money-pound. The libra was a weight and never a coin; the earliest Roman coin was a bronze 'aes' (which just means a unit or one, and from which our card ace gets its name). The aes originally

weighed a libra, roughly our pound-weight, so it is not surprising that it was afterwards much reduced in size. Both the Italians and the Turks still have a 'lira'.

'd' is the first letter of 'denarius'. This was a silver coin first issued about 190 B.C. The name survives in the 'dinar' of Iraq and Yugoslavia (Plate II, (iii)).

's' stands for 'solidus'. The Romans issued an 'aureus', meaning 'the golden coin', in 83 B.C. and it was re-named a solidus about 400 years later because its half and third were then also being coined, so it was called the whole or 'solid' coin. The French 'sou' derives its name from solidus, which has also given us the word 'soldier', who is literally a man who fights for solidi as his reward, not for patriotism.

After the Romans left, the Britons copied their coins for some time and then struck out on a new line of their own in gold and silver and copper. The silver coin was the one most in use and from its name, a 'sceatta', we get our expression to go 'scot free', i.e., without the payment of a sceatta.

In the reign of Aethelberht II (A.D. 748-762) a large, thin silver coin took its place and this was called a penny. King Offa (A.D. 757-796) made heavier pennies, 240 out of a pound-weight of silver; this penny was a copy of the denarius of Pepin, King of the Franks, who had decreed that 240 of his denarii should be coined out of a pound-weight of silver and we have had 240 pence to the £ ever since, and our table of troy weight (20 pennyweights = 1 ounce, 12 ounces = 1 pound) still has 240 pennyweights to the pound-weight as when the pennyweight was the actual weight of a penny (Plate II, (v)).

The origin of the word 'penny' is a source of much

debate. It may be (1) from Latin 'pendo', to weigh or to pay out (the second meaning arising from the primitive way of paying by weight). Our words 'spend' and 'expense' come from this source; or (2) from Old French 'pan', a pledge, from which our word 'pawn' comes; or (3) from Anglo-Saxon 'panne', a pan, as many early coins were made in a mould shaped like a pan or saucer. In early days penny was often spelt 'pennig', which shows that the German 'pfennig' is allied to it.

The word 'shilling' is derived from the Saxon 'scyllan', to cut, and is related to the words 'shearing' and 'sharing'. The ancient Scandinavians and Celts used to break pieces off their gold armlets and neckchains to make payments, and the 'scyl-ling' would be a little piece cut off, 'ling' being a diminutive ending. In a somewhat similar way, the natives of the Upper Congo at the end of last century cut pieces about a foot long from coils of brass about the thickness of a stair-rod, which were specially made and exported from Birmingham for this purpose, and these pieces were then used as currency for articles of small value.

Curiously enough, the word 'shilling' was in use from the sixth century, meaning sometimes four and sometimes five pennies, but there was no corresponding coin. After the Norman Conquest it became fixed as twelve pennies, and as the medieval solidus was worth twelve denarii, the words 'shilling' and 'solidus' became equivalent, and the abbreviation 's' could stand for either. An old form of s, used until last century, was \int , and the stroke we now use in 2/11 $\frac{1}{2}$ d. is merely this letter with the curling ends omitted for speed.


When William the Conqueror had succeeded in

establishing his claim to the throne of England, he did not wish to stir up any unnecessary ill-feeling, so he ordered that the Anglo-Saxon penny should be retained in use and not be replaced by Norman coins, and for another two hundred years the silver penny was practically the only coin in England. It retained its original standard of purity of only eighteen pennyweights of alloy in the troy pound of twelve ounces, that is, three-fortieths of each coin was alloy, the rest pure silver. Absolutely pure silver (or gold) is too soft to stand up to the treatment a coin has to endure in its passage from hand to hand, so some alloy is an improvement rather than a detriment.

It is a matter for pride that this standard of purity was maintained all through the centuries, except in Tudor times, down to 1920. Why it had to be discarded at last will be seen later. The weight of the coins, however, had no such tradition of constancy. As trade and industry developed during the Middle Ages, the need for more coins increased enormously in Europe; but few fresh mines were discovered, so there was very little more metal for use than before. The only way more coins could be produced was by putting less metal into each coin. This was quite reasonable, for the value of any commodity rises when there is a shortage of it, so that if silver is in great demand and is scarce, its value rises, and therefore a coin with less silver in it should purchase as much as a bigger coin did before. But the size of the coins was sometimes reduced from less worthy motives, for when kings were short of money they sometimes passed laws reducing the size of the coins so as to get more profit out of their minting. As a result of these two causes, the size of the pennies got less and less until in

Elizabeth's reign one weighed only approximately eight grains, about one-third of what it did in Anglo-Saxon days.

Since the twelfth century the word 'sterling' has been used to distinguish the coinage of England from others, and the tradition is that the name comes from a race of Easterlings in Eastern Germany who were particularly skilful in minting and were called in by Richard I to improve his currency. But there is no official record of such a visit, and Richard was much more interested in getting money out of his subjects to finance the Crusades than in improving the little he left untouched. More probably the word is Anglo-Saxon from 'staerling', a starling, and refers to the four birds conspicuous on most of Edward the Confessor's coins, or else from 'steorling', a little star, which is also seen on some of our ancient coins. In early days the word was sometimes used as the equivalent of the silver penny, e.g., 'the value is four sterlings', and at other times as a standard of purity, 'coins all of the old sterling', the transference being probably due to the maintenance of the old standard of fineness of the silver coinage through the centuries.

Prices in medieval times were very different from prices to-day; for instance, in 1314 complaints were made to the King that the market prices at Oxford ran unreasonably high; a hen cost a penny and you could buy only twenty eggs for a penny! Thus with a labourers' daily wage of three-halfpence, small change was a necessity. Although halfpence were in existence as early as A.D. 872 (during the reign of Halfdene) often they were obtained by cutting the pennies in two or four so that a halfpenny was in shape D and a farthing, or fourthing, as it was called originally, was like this— .

Many of the old pennies had crosses on one side which, though probably not intended to aid in this cutting process, were very convenient for fair division. The inhabitants of Tibet still cut up Indian rupees like this and use the pieces for small change (Plate II, (vi)).

The first regular issue of round halfpennies and farthings was made in 1279 and these were of silver like the pennies. The great magician Merlin had, according to an old story, prophesied that Wales would lose her independence when the King of England made his money round, and Edward I conquered Wales in 1282, three years after issuing these round halfpennies and farthings, so those who remembered the prophecy said this was obviously the fulfilment. In spite of the new coins, people went on cutting up pennies at times when short of change, even as late as the fifteenth century.

Edward I issued at the same time a bigger silver coin called a groat or gross (because it was a larger, i.e. gross, coin), which was worth fourpence. Edward III added a demi-groat or twopenny coin. Bigger coins than the penny were becoming necessary by then, because the amount of trade grew very rapidly during the thirteenth century and merchants began to find they needed a great many pennies to conduct their business, and the groat saved time and trouble in counting.

Coins of greater value would save still more time, and the Crusades had brought Westerners into contact with Eastern countries where gold coins were in use, so several European countries took to coining gold as well as silver about this time. Henry III in 1257 made some gold pennies, weighing as much as two silver ones and valued at twenty of them, but they disappeared as soon as they were issued. For gold and silver are wanted for many

purposes besides coins—jewellery, silver plate, gold lettering—and therefore have a market price, which, like every other price, varies from time to time and from place to place according to the supply and the demand. Henry was rating gold ten times as high as silver in his pennies, but the market price of gold was more than ten times that of silver and by melting down the gold pennies the metal could be sold for more than twenty pence of silver. This was England's first experience of this sort, but it happened again and again during the centuries to follow that either the gold or the silver coins suddenly seemed to disappear from circulation. For if in England gold is twelve times as valuable as silver, while in France it is only ten times as valuable, any Frenchman can exchange ten ounces of silver, or French silver coin, for an ounce of gold, bring that here and get twelve ounces of silver and return with two ounces profit, and there will be a steady drain of silver from England to France and gradually all the English silver coins will disappear. Penalties and laws forbidding the export of coin or bullion have proved no use against human avarice; no remedy was found until coins became tokens, and not worth their face value.

The first regular gold coinage was in Edward III's reign. He issued gold coins in 1344 worth six shillings to be called florences or florins because they were modelled on those of the city of Florence, which were much admired for their fine workmanship (Plate II, (vii)). Edward made the opposite mistake to Henry III, for he put less gold in each coin than one could buy for six shillings of silver. Merchants, however, insisted on being paid in silver and the coins were withdrawn within a year. They were replaced by a coin called a noble,

from the noble metal of which it was made, issued at 6s. 8d. A new issue of this by Edward IV was rechristened a royal or rial. By that time its value had risen to ten shillings and a new coin of its old value was added, called an angel because it had the Archangel Michael slaying the dragon as its device. The angel was the coin used when people were 'touched for the King's Evil', as a cure for scrofula. The value of the angel has left its mark in the lawyers' fee of 6s. 8d. down to the present time.

In 1489 Henry VII issued a double-rial (worth twenty shillings) which bore a design of the sovereign seated on his throne in his robes of state, and therefore became known as the sovereign. We also owe another of our present coins to Henry VII, for in 1504 he issued a silver coin worth twelve pence which, though called a testoon at first, soon became known as a shilling. And so the shilling at last got a body after being only a name for centuries (Plate III, (viii) and (ix)).

Henry VII's coins showed great improvement in design and workmanship on any previous ones and he must have 'turned in his grave' during his son's reign at Henry VIII's treatment of his coinage. Having squandered the fortune left him by his economical father, he adulterated both the gold and silver coins to provide himself with money for luxury and display out of the profits.

The gold coins so far had had only $\frac{1}{12}$ of alloy in them; Henry ordered coins with one-twelfth alloy to be issued as well (Plate III, (x)). The first coins of this new standard (in 1526) were called crowns and half-crowns because the design on them was a shield with the Arms of England with a large crown above. So that, like the florin, the

first crowns were of gold and not silver as the modern coins of these names are. All gold coins since Charles I's time have been made of this 'crown gold', though the gold crowns themselves were abandoned in Charles II's reign.

Henry treated his silver coins even more shabbily than the gold. He lowered the standard of purity of the silver by degrees until two-thirds of each coin was alloy, chiefly copper. This soon showed through, and people said that the wretched coins were blushing for shame at their own condition. Shopkeepers and merchants demanded more of these worthless coins in exchange for goods, and so prices rose and the public paid for Henry's extravagances by dear food and clothing. One slight consolation to his subjects was that the copper showed through especially on the end of Henry's nose, as it was in the centre of the coins and got most wear, which gave his image a most dissipated appearance. He left the country's finances in such debt that the advisers of the young Edward VI had to clear it off by debasing the coinage further still, and they issued silver coins three-quarters alloy—the worst coins England ever had—but as Edward remarked in his private diary, now in the British Museum, they ordered 'the same to be made and printed with the hole (i.e., whole or full) face and inscription of our most deere late father', instead of the new king, so that the sins of the father might not be visited on the child in this case. When the financial state of the Exchequer had improved, much better coins were issued and Elizabeth I called in all these bad coins in 1562 and restored the 'old standard' of purity of the silver.

To Edward VI we owe the introduction of several of our present coins: in 1551 silver crowns were issued (of the value of five shillings then as now), and half-crowns,

and sixpences and threepenny-pieces. Elizabeth in 1561 added silver three-halfpenny and three-farthing coins but these were not very popular, so were withdrawn after twenty years.

In Elizabeth's reign there was a greater variety of coins in use than ever before or since; nine gold coins, some of standard and some of crown gold; and of silver, the crown, half-crown, shilling, sixpence, fourpence, threepence, twopence, three-halfpence, penny, three-farthings, and halfpenny; altogether twice as many as the coins of Elizabeth II. It must have been very confusing to have so many silver coins differing little in value and therefore in size, and at the current price of silver in Tudor times, the amount in the smaller ones made them awkward to handle and difficult to mint. The smallest of all, the silver farthing, had been given up in Edward VI's reign (Plate III, (xi)).

But farthings were useful for small change, and James I gave permission to Lord Harington to make and issue copper farthings. One reason for issuing them privately was that it was considered below the dignity of the Mint to work with such base metal and another was that though it was decided to give eighty-four of them (twenty-one shillings' value) for twenty shillings of silver to encourage people to use them, the copper in them would not cost nearly twenty shillings and James arranged to share personally in the large profit expected instead of allowing it to go to the Exchequer. But the public was so indignant that comparatively few were bought, though some employers bought sacksful and paid the weekly wages of their workmen in farthings, getting a profit of one shilling in twenty shillings in the process for themselves.

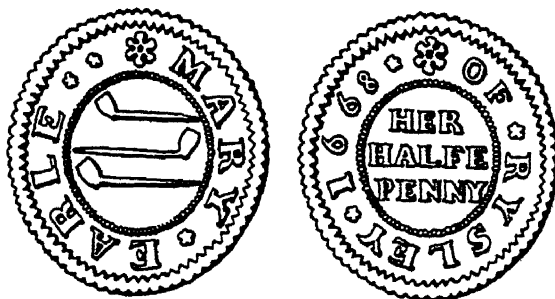


Fig. 3.—One of the Tradesmen's Tokens current between 1648 and 1672. (Note the three clay pipes which indicate that this is a tobacconist's token.)

In Charles I's reign the silver halfpennies were also discontinued, and the dearth of small coins had already forced tradesmen to issue private tokens, stamped with their name and business, to use as change; but these naturally circulated only in the immediate neighbourhood, where the tradesman issuing them was known, and other tradesmen could refuse to take them in payment and often did so. Finally, Charles II in 1672 forbade them and issued copper halfpence and farthings; these were also tokens, that is, the metal in each coin was not worth the value stamped on it and their usefulness did not depend on their intrinsic worth, but on the general willingness of everyone to receive them and use them as exchange for goods, an idea which has been extended until at the present day all the money we use is token money, either paper or of metal.

Chapter III

MODERN ENGLISH COINAGE

THE reign of Charles II marks the beginning of modern coinage, for in 1662 the improved method of minting known as milling was adopted. Many old coins were, and Chinese coins still are, made by pouring hot metal into a hollow mould; our coins, up to 1662, were made by placing a lump of metal of the correct weight between two blocks, called dies, previously prepared with the designs, and then bringing down a hammer on top of the upper die. This is much more difficult than the Chinese way, though harder for counterfeiters to copy. But several blows of the hammer were usually necessary before the impression of the design was satisfactory, during which the dies often slipped and the design would be blurred, or the metal would exude between the two dies, leaving a plain rim which dishonest folk could easily remove and use to their profit.

The improvement known as milling consisted of having the hammer moved by machinery which derived the power that worked it from a mill, worked by horses. This increased the force of the blows so that only one instead of several was needed to make a deep enough impression on the coin. At the same time a sort of collar was invented to prevent the metal spreading during the blow, and words or markings of some kind were put on the inner side of this collar; the hammering caused these to be stamped round the edge of the coin, and the term 'milled' came to be applied to any coin which was

so decorated on the edge. These markings were not mere decorations, however, for their chief purpose was to make it impossible to clip the coins round the edges without it being detected. All our silver coins are milled nowadays, but not the bronze ones.

In 1663 Charles II issued a new kind of gold piece, made from some gold bullion that had been sent to the Mint from Guinea in West Africa by one of the trading companies which at this time were being formed for various kinds of foreign trade. From this origin the new coins were given the name of guinea. They were valued at twenty shillings like the old sovereign. Two-guinea and five-guinea pieces were also coined.

The old hammered money was not withdrawn from circulation when the new milled money was issued. Now if good and bad coins are in circulation together, people tend to hoard the good ones and pass on the poorer; most of us like to keep any new coins we get, but get rid of battered ones as quickly as possible. Also, foreign merchants will insist on being paid with the better coins and will take them abroad with them, and as a result soon there will be no good coins in circulation. This is known as Gresham's Law, after the great financier of the reign of Elizabeth I, the builder of the first Exchange in London, who stated in a letter to the Queen that 'Bad money drives out good'.

So the result of having the old and the new money both in use was that the new milled money disappeared into people's purses and stockings, or went to foreign parts, and the old clipped and badly worn silver coins that were left to circulate led to perpetual arguments; shopkeepers refused to accept them and workpeople protested against receiving them in their wages. In

consequence, people were willing to pay more than twenty shillings in silver for a gold guinea which was sure of being accepted when offered as payment anywhere, and so the value of the guinea rose even to as much as thirty shillings in the reign of William and Mary. Finally, William 'called in' all the old hammered coins in 1695; that is, he named a date before which the Mint would give new milled coins in exchange for them but after which they were to be worthless and no one was to use them. The Mint recoined all those that it received into milled money, but the worn coins, among which were many counterfeit ones of base metal, did not make nearly so many coins of full weight and purity, so there was a heavy loss on the reminting. This loss was defrayed by a special window-tax, which was based on the number of windows in each house; in houses of this period that are still standing one can often see windows that have been bricked up; this was done when the tax was announced so as to lessen the amount to be paid.

When the silver coinage had been so much improved, the value of the guinea dropped again; also about this time the gold mines of Brazil began to produce larger supplies of gold, and this increased supply lowered the price of gold until, in 1717, a law was passed that a guinea was to be equivalent to twenty-one shillings of silver. This is still its value when we use the term for subscriptions to golf clubs and donations to charity. This value was worked out as being a just one by the great mathematician Sir Isaac Newton, who took his duties as Master of the Mint very seriously and thought the improvement of his country's coinage a matter well worth his study.

In 1729 the minting of the silver fourpence, threepence, twopence, and penny were all discontinued, except

for the distribution of money to poor people by the King on Maundy Thursday, for which they are still coined. The silver fourpence was issued again from 1836 to 1856 in response to a request by an M.P. who said it would be useful for paying cab fares (the charge then being eightpence a mile), and the silver threepence was restored in 1845 and has remained in circulation ever since, but the silver twopence and penny went for good in 1729. For some time after they had been discontinued there was an acute dearth of small change again, till in 1797 copper twopenny and penny coins were issued. These contained their full value in copper and the twopenny-piece weighed as much as six of our present pennies (Plate III, (xii)). They were made not at the Royal Mint, but by a contract with a firm in Birmingham; this started a connection between that city and our coinage which still exists. They were so heavy and cumbersome that the twopenny-piece was issued only for a year, and the penny was soon reduced in weight, and became a token as the halfpenny and farthing already were. Never since has there been any attempt to make coins of cheap metal worth their face value, though these coins were mere featherweights compared with the enormous slabs of copper issued in the seventeenth and eighteenth centuries in Sweden; an eight daler (dollar) piece dated 1656 is two feet by one foot, and weighs $32\frac{1}{2}$ pounds, and is the heaviest coin in the world. One must have needed a wheelbarrow instead of a purse to carry such money about.

From 1860 bronze (i.e., copper with a small proportion of tin and zinc) has been used for the penny and its fractions, and this enabled the weight to be further reduced. It takes three of our present pennies (and only five halfpennies or ten farthings) to weigh an ounce.

Even so, the penny is much heavier than any coin of about the same value in other countries in Europe, and there have been requests made to have it reduced in size, but, apart from the labour involved at the Mint, it would upset the thousands of penny-in-the-slot machines that are in use.

In 1816 it was decided to make the silver coins into tokens by reducing the size. This meant the end of the struggle to keep both gold and silver coins in circulation against the inevitable tendency of whichever was undervalued to disappear as explained on page 25.

Token money depends for its successful circulation on the confidence the people have in the issuing authority to exchange the tokens at their face value on request; obviously if we did not feel certain that forty sixpences would be everywhere exchangeable for a pound note, we should not be so ready to use them, and their value would sink to that of the metal in them and by Gresham's Law they would drive the standard coinage out of circulation. On the other hand it is not advisable to flood the circulation with coins that are intrinsically valueless—which is why the issue of private money tokens has always been discouraged—and to avoid the need for their issue in very large quantities, limits are put on the amount for which they are legally usable—in England in the case of silver, up to forty shillings, and for copper, up to one shilling. The fact that the Exchequer makes a good profit on the issue of token money is a useful, but minor, consideration. A greater one is that as they are not worth melting down or exporting, they remain in circulation—since 1816 there has never been such a severe dearth of small change as used to occur.

After the establishment of the decimal system of

coinage in France and elsewhere, an agitation began for its introduction into England, and as an experiment, a coin worth two shillings, one-tenth of a pound, was tried in 1849, and, as it was about the size of the current Dutch and Austrian florins, it was given that ancient name. The first ones were received with a storm of protest as the letters D.G. (*Dei Gratia*), which had been on all our coins since Edward III's reign, had been omitted from them. The issue of these 'Godless Florins', as people dubbed them, had to be cancelled and a new coin issued instead, which gradually became popular. The minting of half-crowns was temporarily suspended (from 1851-1862) to see if the florin would take its place, but requests were made for its restoration and since then we have had both coins in spite of their similarity of size. The demand for both continues; in some years more half-crowns, in others more florins, are asked for and minted.

A double-florin or four-shilling piece was tried out in Queen Victoria's Jubilee issue in 1887, but it was easily confused with the crown and was discontinued after six years.

Many people do not realise that the crown is still minted in small numbers from time to time, for example, the Jubilee of King George V and the Coronation of Elizabeth II. Its old nickname of 'Cartwheel' showed public opinion of its clumsiness, but with post-war rises in prices, there has been some demand for its regular issue, by M.P.s and others.

In the wars against Napoleon, rumours that the Bank of England had not enough money to meet all its debts caused a 'run' on the Bank by people anxious to convert their banknotes into gold, and the war interfered with

trade and made it difficult to get gold from the countries that had gold mines, so the coinage of guineas was suspended. When the wars were over and it was decided to issue gold coins again, the awkward value of twenty-one shillings was abandoned, and the coins issued in 1816 were made worth twenty shillings and the title of sovereign was revived for them, though instead of the sovereign-in-state as device they had a representation of St. George and the Dragon. The name was appropriate, however, in that this was the most important of the coins, just as the sovereign is the most important person in the kingdom (Plate III, (xiii)).

A similar need to save gold for financing war led to the substitution of paper money for half-sovereigns in 1915 and for sovereigns in 1917, though some of the Colonial Mints continued to issue them till as late as 1932. Sovereigns were again minted in 1957-9 for foreign trade, but not for home use.

Another problem created by the First Great War was due to the rise in the price of silver. In 1913 this was about two shillings an ounce, but by February, 1920, it rose to 7s. 5½d. an ounce, and the amount of silver in a half-crown was worth 3s. 4d. and in a shilling 1s. 4d. Obviously the Mint would lose heavily in buying silver for coins, and anyone could make a good profit by melting down the coins they had and selling the silver as bullion. To meet the emergency the old standard of purity which had been maintained for so many centuries had to be thrown aside, and it was decided to make the coins half-silver, half-alloy.

The first experiments, with copper as the alloy, were very unsatisfactory as the unpleasing appearance of the coins of 1920 to 1926 still in circulation shows. Fearing

that people would mistake them for counterfeit brass ones, and refuse to take them, a false complexion was for a time given them by a thin coating of silver, but this, like many aids to beauty for human faces, was very expensive and soon wore off. From 1927 a little zinc and nickel were added, and less copper, with much better results.

But Britain borrowed eighty-eight million ounces of bar silver from the United States under Lend-Lease in the Second Great War, and undertook to repay it in the same form. To make this possible, Parliament decided in 1946 to abolish the use of silver and as the old coins came back to the Bank they were melted and the silver in them (that in the shilling was worth fivepence at the time) paid the debt; the new coins of cupro-nickel (copper and nickel) are worth only a fraction of a penny intrinsically.

The silver threepenny-bit has never been very popular in England; its nickname 'Tom Trip and Go' expresses the ease with which it can be lost. In 1937 the threepenny-bit of nickel-brass was added to the coinage; its twelve sides make it easy to distinguish by feel in the dark from the other coins of about the same size, and its thickness makes it more easily extracted from a bus conductor's satchel, and also prevents it being used to defraud in a shilling slot machine. Silver threepenny bits ceased to be coined in 1945, except for Maundy money.

In the years 1957-59, ten million gold sovereigns were minted for the National Reserves—but not for home use, as counterfeits, which were damaging the reputation of the sovereign as a medium of exchange, had been made in quantities in Italy and elsewhere.

In 1960 a new crown piece was issued, in response to requests, and the farthing, which had ceased to be of use, was abolished.

Chapter IV

PAPER MONEY

THE use of paper money is not a modern invention as one might think. Sir John Mandeville wrote an account of his visit to the Great Chan of Tartary about 1327 and said (in modern spelling) 'This emperor maketh no money but (i.e., except) of leather imprinted or of paper. And when that money hath run so long that it beginneth to waste (i.e., wear out) then men bear it to the emperor's treasury and then they take new money for the old'. Some of the strangest paper money ever issued was that used in Canada about the end of the seventeenth century. There was a shortage of coins in the colony at this time and also of paper and printing machinery, so the Governor collected all the packs of playing cards he could lay his hands on and wrote on the back of each card an amount for which it was to be current and signed and issued them. They were used so readily instead of coins that Governors following him in office continued the practice for about seventy years.

The earliest paper money in England consisted of the receipts given by goldsmiths with whom, in Stuart times, before there were banks, people used to lodge their gold and silver plate or coins for safety. These receipts could be passed on as payment for debts more easily and safely than the actual metal.

In the latter part of the eighteenth century—a time of rapid development of mines, machines, and canals—more and more money was wanted for these undertakings and

banks sprang up everywhere to lend money to those who wanted it, obtaining it from others who had money to spare and had put it in the bank. Each bank issued its own banknotes, and at first they were not issued for fixed amounts, but had a blank space like our cheques, which could be filled in with any amount desired.

It is unlikely that all the notes (which are promises by the bank to pay out the amount mentioned on them when requested to do so) will be brought in for payment all at the same time, and as long as conditions are normal and the public has confidence in the ability of the bank to make what payments are asked of it, it can safely issue notes to considerably greater value than the deposits or investments it owns; but if a report that a bank cannot meet its obligations sends everyone at once to get cash for their notes, disaster will ensue. Readers of *Cranford* will remember the account of the failure of Miss Matty's bank. All the dwellers in Darlington know the story of Backhouse's Bank; how Lord Darlington, after a quarrel with Jonathan Backhouse, made all his tenants pay their rent to him in the notes of this bank and accumulated them, intending, when he had more than he thought could be cashed all at once, to ask for coin for them suddenly and so ruin the banker. But Jonathan got wind of the plan, and, dashing to London, returned with supplies of gold in a chaise. A few miles out of Darlington a front wheel came off, but rather than stop for repairs, he 'balanced the cash' by piling the bags at the back of the vehicle and drove into Darlington on three wheels, but in time to pay Lord Darlington's agent when he arrived with the notes.

Nowadays the number of banks is few, and each is vastly more wealthy, and, instead of issuing their own

(Scottish banks excepted), they all use Bank of England notes, made legal tender in 1833, that is, except at the Bank of England itself no one could refuse to accept them or insist on being paid in gold instead of in these notes.

In these things we differ from many other countries. In the United States, for instance, there are many different kinds of paper money and as recently as 1933 there was a terrible succession of bank failures which shook the whole financial system of the country. During and after the First Great War, municipalities in France and Germany issued notes for small amounts which were of use only in the vicinity of the issuing town and unwary travellers often had them passed on to them and, when they arrived at another town, found the shop and hotel keepers would not accept them when they tried to pay their bills with them.

In the early days of banking banknotes were issued for quite small amounts, even for as little as sixpence in Yorkshire, but after 1777 it was forbidden to issue notes of less value than five pounds, and there was no paper money except notes for five and ten pounds and higher values, until 1914.

When the First World War broke out, the Bank of England's store of gold was heavily drained by people who wanted to exchange their notes into gold for greater safety, as they thought. To meet this emergency and to provide extra money to finance the war, the Treasury issued notes for one pound and ten shillings. According to the law anyone could demand at the Bank of England to have them exchanged for gold sovereigns or half-sovereigns, but there was no advantage to be gained by doing so unless the gold could be exported and sold abroad at a higher price, and the risk of loss by

torpedo or capture prevented speculators from trying this. But after the war the sovereign became more valuable than a pound note. For the printing of all this paper money meant that there was much more money in existence than before. When there are large supplies of anything, that thing gets cheaper, and money behaves like anything else; when it is plentiful, it is of less value, and a certain amount of it will not buy as much food or clothing, for instance, as before. Or to buy the same amount of food or clothing more money will be needed. So, though it seems exceedingly odd, an extra supply of money leads to a rise in the prices of everything that money can buy. And among the things of which the price will rise is the very metal of which the money is made. But if the price of gold bullion rises, the gold in a sovereign is worth more than it was previously, and therefore a sovereign will become worth more than a pound note. Everyone searched their drawers for old gold brooches and false teeth and sold them along with sovereigns, and the goldsmiths had a busy time melting and exporting until the export of gold bullion was forbidden and the obligation of the Bank of England to give gold in exchange for its notes was cancelled.

By 1925 it was thought that we could return to the Gold Standard—that is, the notes should be again exchangeable for gold—and an Act was passed stating that the Bank of England would give gold bars in exchange for notes. As each bar was worth £1,700 and anyone would have had to take that number of notes to the Bank to get one, the use of gold was effectively limited to international or large industrial transactions. But even that proved too great a strain on our resources, and in 1931 Great Britain went off the Gold Standard again.

The price of gold has since continued to reach fresh records. It rose with a sudden jump when the Second World War broke out, and by 1957 the value of gold in a sovereign had risen to £2 18s. 9d.

After 1928 the one pound and ten shilling notes were issued by the Bank of England instead of the Treasury, though the National Exchequer, and not the Bank, got the large profit obviously made by their manufacture.

The new notes issued in 1959 have a royal portrait, but still bear the signature of the Chief Cashier of the Bank of England (L. K. O'Brien) and are issued 'for the Government and Company of the Bank of England', which was a private company of shareholders until its nationalisation in 1946.

As soon as the Second Great War broke out, paper money of smaller value was added to our currency by using postal orders, which put into circulation an extra and unlimited amount of money for the carrying on of the war. But for small amounts paper has few advantages over coins; it soon gets very dirty and dilapidated from frequently changing hands, and it is easier for forgers to put counterfeit paper money in circulation when there are large quantities and many varieties in use. So the order making the postal orders legal tender was cancelled after three-and-a-half months and, as before, no one is bound to accept them if offered in payment, as they must the one-pound and ten-shilling notes.

It is exceedingly unlikely that we shall ever again have money which acquires its value from the intrinsic worth of the matter of which it is made. The value of money lies in the confidence men feel in its power to purchase the necessities and luxuries which they desire. As long as it can be readily exchanged for these things, it matters

little of what substance it is made. A metal coin or a paper note enables its possessor to acquire the produce of the soil and of the factory and to satisfy his bodily needs; he can use them to buy a car or a wireless set, and so share in the benefits brought about by man's inventions, and they will purchase books, pictures, or a seat at a cinema or theatre, so that he can see or possess beauty in some of the forms the imagination of men has led them to produce. These things, and not money, are the real wealth of an individual and of nations.

This has been brought home to all of us in the post-war years, with their problems of increased prices and increase in wages. But these are not new problems and the variations in the cost of living through the centuries form an extremely interesting subject for study. Prices varied very little for about 300 years until in Henry VIII's reign there was a very steep rise, which continued, though less steeply, into Stuart times. Then, in the eighteenth century, prices were lower, to rise again in the nineteenth; the causes of these changes would take too much space to enumerate them here.

But if in the fourteenth century a foreman's pay was only fourpence a day, yet his meat cost him only a farthing a pound, he could buy land at sixpence an acre, or a whole sheep for 1s. 5d. In Victorian days a child might get as weekly pocket money a literal 'Saturday penny', but she could buy with that penny one of Stead's *Books for the Bairns*, with the whole story of 'Robin Hood' or 'Robinson Crusoe', or a quarter-pound bag of sweets. Who is to decide in which age living was really the cheapest? Certainly it is not the amount of money, but its purchasing power, that constitutes riches.

Chapter V

THE WORK OF THE MINT

'WHOSE image and superscription hath it?' was the question Christ asked of the Pharisees when they had asked Him if it was right to pay tribute and at His request had produced a denarius. And the answer was 'Cæsar's'.

The stamps on the earliest coins would be those of the merchants who had assayed and weighed them, but the name of a king or a city would be more widely known than that of a private individual and coins stamped by royal or state authority would be accepted more readily and so it would be a benefit to traders to use them, and the spread of these coins added prestige to the ruler or state whose name and fame were made known wherever these coins might go. So from the earliest days the right to issue coins has been regarded as a prerogative of royalty or the state.

Before England was united into one kingdom each king had his own coins, made in his own mint. In France and Germany the nobles issued their own coins and managed to keep the right to do so, but in England the prerogative of the king was strenuously guarded and the only coins not issued by royal order since the tenth century are those of some unruly barons under the weak King Stephen. But long after England was one kingdom the mints all over the country remained in use. 'Moneyers' in each town were given the right to issue the king's coins there and were given certain privileges such as freedom from rent and taxation. The name of the

moneyer was stamped on the coin until the time of Edward I, and that of the town till Tudor times. The Royal Mint near the Tower of London received its earliest charter from King Athelstan in A.D. 928 and celebrated its millennium in 1928, but, as Roman coins have been dug up near, it may be that the Roman mint of London was on the same spot, which would make it nearly twice as old.

The moneyers also acted as exchangers of foreign coins for English ones or of gold for silver. We submit to a small percentage being deducted at a Bureau de Change when we change our money before going abroad, but the moneyers were allowed to keep a little for the trouble of changing one English coin with another; Edward III, for instance, decreed with regard to his gold nobles (worth 6s. 8d. of silver) that whoever wished to buy one should pay 6s. 8½d. for it, and anyone who exchanged one for silver coins should receive only 6s. 7d.

In days when transport was difficult and unsafe, it was a convenience to have mints in different places, but it was easy for the moneyers to make dishonest profits without being found out, and the existence of so many duplicates of all the necessary equipment for coining made it hard to prevent some of it getting into unlawful hands. Many and ferocious were the decrees passed against false moneyers and forgers as well as those who debased the coins by clipping round the edge or by boring a hole in the middle and filling it with cheaper metal.

There were at least sixty-nine mints in William I's reign, but most of them ceased to work regularly by the fourteenth century and Edward VI finally closed them. Since then until quite recently the Mint opposite the

Tower of London has been the only place where coins have been minted except in times of extreme urgency such as the sudden huge demands in William and Mary's great recoinage of the old 'hammered' money, or during Charles I's travels with his army in the Civil War. Of late years the lack of space at the Tower Mint made it necessary to establish an auxiliary mint at Iwer Heath, in Bucks, in 1940; and two firms at Birmingham and King's Norton produce some of the foreign coins and less important Commonwealth ones. For the work of the Mint has grown to include much besides our own coinage. Canada, Australia, and South Africa all have their own mints, but for all the other parts of The Commonwealth the work is done in England, and several other countries (Eire, Iraq, Uruguay, Iceland, etc.) entrust their coinage to us too. Some of these are still of silver; but no gold coins have been minted since 1939 except some sovereigns for the nation's gold reserves.

The ancient ceremony known as the Trial of the Pyx still takes place annually. It was instituted by Henry III to keep a check on the moneyers in the various towns. Samples of the coins minted had to be placed in a pyx or chest and kept under lock and key until such time as public trial was made of them at the Exchequer, the coins being weighed to see if they were deficient in weight, and a proportion being melted down to test their quality. In James I's reign it was ordained that the jury should consist of 'twelve of the most wysest and discrete of foremen of the Company of Goldsmiths', and this company, one of the most famous of the ancient London bodies of merchants and craftsmen, still discharges this duty. Nowadays the ceremony has extended its scope to include coins from the mints in the

Dominions, which may have to come half round the world to stand their trial.

In the coinage of those colonies which use our money system there are often modifications to meet local needs. Silver 'groats' or fourpences are coined for British Guiana; a little coin worth one-tenth of a penny is struck for British West Africa, and Malta has coins of the value of one-half and one-third of a farthing. Even the Channel Islands, though they use our silver coins, have their own bronze coinage. Paper money of the value of two shillings and one shilling is also supplied to British West Africa, where the natives have a habit of hoarding coins, and so causing a shortage which the more perishable paper money tends to prevent.

One very curious production has been the Maria Theresa thalers, or dollars, for use in Arabia, North Africa, etc. The silver dollars of this Empress of Austria, who died in 1780, had been introduced into these parts in trade, and became so popular that their minting was continued after her death. England first minted copies in 1867 to pay for fighting in Abyssinia, finding these coins more acceptable than her own currency, and Mussolini issued a similar coin for the Italian colonies in Africa for the same reason. The Mint continues to coin them with the portrait of the long-dead Empress for our own trade, and for the restored Emperor of Abyssinia, in varying quantities; 272,429 in 1957 but only 202 in 1959.

The various designs on coins are a very interesting field of study. Even in the early Greek coins there was great variety; deities, animals, and objects of all sorts being used. Sometimes, perhaps, the design showed the value; the coins of Crete, for instance, had kettles and

three-legged stools on them and may have been the price of these things, but more often the design was merely a badge of identification like our inn signs ('The Red Lion', etc.) and bore no more connection with the purchasing power than the pigs and hens on the new coins of the Irish Free State. The earliest coins with a representation of a reigning monarch are those of King Darius of Persia at the end of the sixth century B.C. The Jews obeyed their commandment against making any graven images and would permit no human figure or animal to appear on their coins. Muhammad laid the same commandment on his followers and the majority of the coins of Muhammadan countries to this day keep this rule.

In England it has been the custom almost without exception to have a representation of the king on each coin ever since King Edgar (A.D. 959-975) ordered his image to appear on all his coins, but there was little attempt to make it anything like a portrait. In fact there were 'stock patterns' which were continued from reign to reign; on the silver pennies, for instance, the same face appeared for over 200 years, the king's name being altered as necessary. As no coins before those of Henry VII (except for a few of Henry III) bear any numeral after the king's name, it is therefore very difficult to decide to which Henry, Edward, or William an old coin belongs. The first king to have a real portrait on his coins was Henry VII; the renaissance of learning which had taken place in Europe had led to an increased interest in coinage as an art, and as a result there was a great improvement in the beauty of the coins and the methods of making them just about this time.

On our early coins the king is sometimes shown full

face, others show side face or even the whole figure as on the first sovereigns, though after Henry II full face was the usual style; but after Edward VI's reign full face ceased to be used and profile portraits became the invariable rule.

The custom of having the king's head facing in opposite directions in successive reigns began with the introduction of milled money. For the coins which were being prepared for Edward VIII, this rule was going to be broken at his own request, but he abdicated before any new coins had been issued, except a very few twelve-sided threepenny bits (worth £625 each to collectors!) and some African colonial coins, which only bore his title and no portrait. As the portrait of George VI faces left, like George V, the break in the custom will not be apparent.

The appearance of Britannia on the coinage dates from Charles II's reign, being first used on his new copper coinage of 1672. The beautiful Duchess of Richmond is said to have been the model, but the idea was not entirely original, for some of the British coins issued by two Roman emperors, Hadrian and Antoninus Pius, have a seated female figure with a circular shield, and a spear or sceptre in her hand, and the name Britannia (Plate II, (iv)). The name also appears on Roman sculptures, on which she is referred to as a goddess.

The disappearance of the gold sovereign from our currency is to be regretted on artistic as well as other grounds, for the design of St. George and the Dragon which it and the half-sovereign bore and which was on the back of our pound notes until 1959 is considered one of the finest ever appearing on a coin, and the sovereign will probably rank as one of the famous coins

of history, and specimens be treasured by coin collectors for their beauty, quite apart from their enhanced value at present.

The series of 'zoological' coins issued by the Irish Free State in 1928 made a big break with tradition, replacing the usual heraldic kind of design by horse, pig, salmon, and so on. Although this was such an innovation, it met with much approval, though with some jesting—a penny bus ride, for instance, became known as a 'hen-run' because of the hen on the penny. New Zealand copied the idea in an issue of 1933 with coins showing the kiwi and other national emblems. When the coinage for Edward VIII was under consideration, artists were asked to send in designs of a similar nature, but those sent were not considered satisfactory and only the wren, Drake's ship *The Golden Hind*, and the sea-pink or thrift were used for the farthing, halfpenny, and new threepenny-bit respectively. But the idea may be developed in future coinage.

In early days when there were few varieties of coins they could be easily distinguished by their different size, but by Tudor times, when several fresh silver coins had been issued and two grades of gold coins were in existence, confusion was easy. So the innovation made by Edward VI with the first issue of sixpences and threepences of having its value stamped on each coin in words or figures was a useful one and has been continued, as has another custom begun in the same reign—though it did not become general for another hundred years—that of dating each coin with the year of its issue, which is of less importance to the general public.

The circular shape has been used so universally for coins that it is difficult for us to free our minds from a

prejudice in its favour. But the very earliest of all coins were oval. The Chinese have a saying 'Money which is meant to roll round the world should itself be round'; but their knife- and spade-shaped coins have already been mentioned. Greek coins in the shape of fish have been found and the Greeks used bundles of copper spikes for small change. Our twelve-sided threepenny-bit was a novelty in our coinage (though some of the coins used by Charles I during the Civil War had six or eight sides), but did not present the difficulty of manufacture such as Iraq's demand in 1930 for coins with scalloped edges created for the Mint; to make these satisfactorily called for considerable skill and ingenuity.

In many other respects, too, the work of the Mint is of absorbing interest and variety; even to gauge the likely needs of the community needs almost a wizard. There is always a big demand for half-crowns and florins before Christmas, followed by urgent requests for more shillings if January and February are cold. And from time to time a sudden demand may arise for more of one coin than before. For example, at the start of rationing in January, 1940, the prices of butter and sugar were such that a farthing had to be given or received as change in the weekly purchase of sugar by a family with an even number of ration books, and of butter by a family with an odd number, and the Mint, foreseeing this, minted ten million extra farthings and issued them in the first five weeks of rationing. The institution of P.A.Y.E. and the National Health Insurance Scheme each created a greater need for small coins, as wages which previously had been 'round figures' payable in bigger coins suddenly involved payments with many smaller ones.

Sympathetic attention is also given to suggestions

made for changes in the coinage. Recent ones include the idea that the half-crown should be made polygonal like the new threepenny-bit so that it could be distinguished by touch from the florin, and many requests have been received for a twopenny or three-halfpenny-piece to meet changes in prices; the latter would be extremely useful in towns where the minimum bus or tram fare has been raised to three-halfpence; but in addition to the difficulties of altering cash registers, and making extra subdivisions in tills and satchels, etc., the Mint officials decided that it would be 'serious to complicate the calculations and delvings of the housewife in her daily shopping or of the bus conductor producing change in haste by the simultaneous circulation of pence and three-halfpence, or of twopences and threepences'.¹

The normal needs of the public are shown by the requests of shopkeepers and others for supplies of coins from the banks, the banks in their turn getting these supplies from the Mint.

And so we are able to transact our business easily and moreover can pocket our change without, as of old, the constant fear of being defrauded by false coins. And as we do our shopping, or pay our railway fare, it would be well if sometimes we spared a thought for those whose skill has been put at our service, and for those to whose ceaseless efforts for betterment through the centuries we owe the present state of our currency.

¹ Annual Report of the Deputy Master of the Mint for 1939.

Chapter VI

DECIMAL COINAGE

As long ago as 1824 a private Member introduced a Bill in the House of Commons proposing that we should have a decimal coinage, and the florin was added to our coinage in 1849. A society called the Decimal Association was founded in 1854 to work for the decimalisation of our money system and the question has been discussed by industrial committees and at imperial conferences, which is a very necessary preliminary to such a change which must have the support of the business world and the colonies which use our coinage to be successfully made. Many firms already use decimals of a pound instead of shillings and pence in keeping their accounts, and declare that it saves both time and paper. The well-known caterers Messrs. Lyons and Co., for instance, introduced it into that department of their business which deals with all the calculations of costs and found it saved them £5,000 a year.

In 1920 a Royal Commission which had been appointed to consider the question of Great Britain changing to decimal coinage made a long report of its verdict on the matter.

It declared that there would not be much time saved in schools, as some advocates of the plan claimed, because children would still have to learn fractions, and would have to learn decimals at an earlier age than now and would therefore learn more slowly, and it also said that if shillings and pence are turned into decimals of a pound

(for which a rule is often taught in schools) before converting English to foreign money, then calculations of exchange are only longer by this step than they would still be with a decimal system.

The Commissioners admitted that a decimal system is superior to our present one for percentages and for the calculations done in business counting-houses, but declared that for the usual arithmetic of shops and markets ours is better. For when small quantities are bought, the price of a larger quantity often has to be divided, and a shilling of forty-eight farthings which can be divided in eight different ways into two sixpences, three fourpences, etc., is very convenient, especially for dividing into quarters or in calculations with dozens, which are frequently necessary.

In 1960 a joint committee of the British Association for the Advancement of Science and the Association of the British Chambers of Commerce made another report after extensive enquiries among industrial and scientific bodies, the answers to which showed 90 per cent in favour of the change. By this time there were far more calculating and coin-operated machines in use, so that in addition to the advantages in arithmetic, especially multiplication, division, and percentages, the Committee said that the change would enable greater uniformity among makes of calculating machines. It was agreed also that, if we use a metric system of weights and measures, these machines could be used for other purposes. But they estimated that the cost of altering the half-million cash registers in use, together with petrol pumps, taxi meters, etc., would be about £128,000,000 and that this sum would have to be paid as compensation out of taxes.

In 1962 the Government set up a Committee of En-

quiry, which made extensive enquiries among all sorts of people. As a result the Committee recommended an early change to the decimal system, but four of the six members favoured one system, the other two another. These two (the 'finalists' after examining 25 different schemes!) are:

	<i>£1 system</i>	<i>10s. system</i>
Major unit	£1	10s.
Minor unit	2·4d.	1·2d.
Banknotes	£5 £1 50 cents (10s.)	10 units 2 units (£1) 1 unit
Coins	*20 cents (4s.) 10 " (florin) 5 " (shilling) *2 " *1 " *½ "	25 cents (half-crown) 20 " (florin) 10 " (shilling) 5 " (sixpence) *2 " *1 "

* New coins needed.

The £1 system was favoured chiefly in the replies by Banks and Government Departments, because sterling is used internationally, and nationally, for all the trade and investment dealings in the City of London, and it was thought that if we lowered our major unit it might cause distrust and fear that we were devaluating our currency. The 10s. system was favoured by the Ministry of Pensions and National Insurance, transport undertakings (because they did not like the ½ cent for bus fares), the majority of industrial and commercial undertakings, and strongly advocated by most retailers.

The ½ cent is the chief objection to the £1 scheme, for it would figure in retail transactions much more than the halfpenny does now, and there might be a tendency to round prices off to the nearest cent, which would mean a considerable rise in bus fares, newspaper prices, etc.

The 10s. scheme has fewer new coins, and more of the

old ones (under new names), and this would make it cheaper to adopt. It has already been adopted in S. Africa and is to be introduced in Australia and New Zealand.

Experiments comparing the length of time needed to acquire reasonable facility with each scheme showed that eight practice times with the £1 scheme were needed to be as proficient as after five practices on the 10s. scheme.

There is likely to be an increase in prices, because the new 'penny' will be $1\frac{1}{5}$ of the old one and prices may be rounded up to the next new unit rather than down, but it will be the housewife's task to check this by comparing old and new. It is proposed to give every householder a 'conversion table', and every shop should display one,

We are left with the international strong case for the £1 scheme versus the greater adaptibility of the 10s. one, but with unanimity as to the wisdom of changing as soon as we can to some decimal system. Of course, this is the result of the whole civilised world being in agreement about basing its method of counting and calculating on the number ten. If human beings had twelve fingers and toes instead of ten, the nations of the world would probably all be using twelve instead of ten and many sums would be simpler than they are now, for twelve has twice as many factors as ten (not counting one). A few enthusiasts have advocated the scrapping of our system of counting entirely and suggested that the whole world should re-learn to count in dozens, gross (144), and great gross (1,728) instead of tens, hundreds and thousands. But this would be such a stupendous innovation that the probability of its taking place is so small that it is not worth considering as a practical matter, and the best alternative is for all nations to agree in using ten as the basis for their money systems as well as for their numbers.

CHRONOLOGY

- C. 700 B.C. Invention of coinage in Lydia.
 C. 75 B.C. First British coins.
 A.D. 43-388 Roman coins in use in Britain.
 C. A.D. 600 Early Saxon coinage.
 A.D. 748-762 Aethelberht II. First silver pennies.
 A.D. 757-796 King Offa. Silver pennies (240 to the lb.-wt.).
 1257 Henry III. Gold penny coined (equals 20 silver pennies).
 1279 Edward I. Groat or fourpence issued (silver). Round halfpence and farthings first regularly coined (silver).
 1344 Edward III. Gold florin issued at six shillings.
 (Jan.)
 1344 Edward III. Noble issued instead, 6s. 8d. (gold).
 (Aug.)
 1351 Edward III. Demi-groat or twopence issued (silver).
 1465 Edward IV. Rose noble or rial issued at ten shillings (gold).
 1470 Edward IV. Angel issued at 6s. 8d. (gold).
 1489 Henry VII. Double-rial or sovereign issued at twenty shillings (gold).
 1504 Henry VII. Shilling coined (silver).
 1526 Henry VIII. Gold crowns and half-crown issued. Introduction of 'crown gold' for gold coins. Debasement of the silver coinage in this reign.
 1551 Edward VI. Silver crowns and half-crowns issued and sixpences and threepences. Silver farthings went out of use in this reign.
 1562 Elizabeth I Old standard of silver coinage restored.
 1613 James I. Copper farthings issued by Lord Harington.

- | | | |
|------|---------------|---|
| | Charles I. | The silver halfpenny was last coined in this reign. |
| 1662 | Charles II. | Introduction of 'milled' coinage. |
| 1663 | Charles II. | The guinea issued at twenty shillings. |
| 1672 | Charles II. | Copper halfpenny and farthing minted.
Gold crowns ceased to be issued in this reign. |
| 1717 | George I. | The guinea fixed at twenty-one shillings. |
| 1729 | George II. | Silver fourpence, threepence, twopence, and penny abolished except as Maundy Money. |
| 1797 | George III. | Copper twopence (in that year only) and penny coined. |
| 1816 | George III. | Sovereign issued at twenty shillings.
Silver money reduced to tokens. |
| 1845 | Victoria | Silver threepence reissued. |
| 1849 | Victoria | Silver florin issued at two shillings. |
| 1860 | Victoria | Bronze used for penny, halfpenny, and farthing instead of copper. |
| 1914 | George V. | Treasury notes for one pound and ten shillings authorised. |
| 1917 | George V. | Last gold coins minted in England. |
| 1920 | George V. | Standard of the silver coinage reduced. |
| 1928 | George V. | Bank of England one-pound and ten-shilling notes replace Treasury notes. |
| 1937 | George VI. | Threepenny-piece of mixed metal issued. |
| 1946 | George VI. | Cupro-nickel coinage replaces silver. |
| 1960 | Elizabeth II. | Farthings ceased to be coined. |

PART II

WEIGHTS AND MEASURES

Chapter I

MAN AS A MEASURER

OFF the coast of America there stands a lighthouse. No keepers live on it, but as the fog thickens, suddenly its warning note begins to sound and continues till the fog lifts. It is no human hand, but one hundred human hairs, that sound the signal. For hairs stretch when damp; and exact measurements of the amount they stretch has made it possible to use them in a machine built with such precision that the dampness of the fog stretches them enough to complete an electric circuit and start the fog-horn.

Till recently the birthplace of eels was a mystery to the biologists. Each autumn old eels swarmed out from the rivers into the sea, and each spring young ones swam up the rivers, but where they had been born no one knew. Young eels caught in different parts of the Atlantic were measured, and it was found that they were smaller and smaller as they were caught nearer to the great Sargasso Sea; trails of eels of diminishing size led into it from all directions. Measurement had solved the mystery; the old eels evidently congregated and bred there, and then the young eels set out in all directions, growing as they travelled.

Measurement therefore is no dull and humdrum matter, but full of romance and interest, and is essential to knowledge of the truth. Supposing that a traveller who had visited Niagara met one who had seen the Victoria Falls on the Zambesi; each might extol the marvel he had seen, but how shall they decide which is the greater? The

only way would be to compare measurements—which has the longer drop, or over which does the greater volume of water cascade in an hour? Again, men knew of old that the magnetic needle points to the north, but the navigator who knew no more than this might easily come to disaster. Accurate observation and measurements show that the needle does not point exactly to the North Pole, and that the amount by which it errs fluctuates during a cycle of eleven years. Lists of figures recording these fluctuations may look dull, but they mean safety during travel to millions.

But it is not only in a scientific age that measures and weights are necessary; they are as old as trade and building, and very much older than money. Men at first used their own bodies to measure with—convenient and always ready to hand. They used the length of their forearm; this was the 'cubit', of which we often read in the Bible; the bedstead of Og the giant King of Bashan is described as being of iron and nine cubits in length and four cubits in breadth 'after the cubit of a man',¹ i.e., measured by a man's forearm. An old English measure, the 'ell', is said to be derived in the same way, the name being a corruption of 'elbow'. They also used the distance between the tips of the thumb and little finger when the hand is stretched—the 'span'—about nine inches. Goliath's height was six cubits and a span, we are told, and as the Hebrew cubit was about eighteen inches, this makes Goliath about nine feet nine inches tall, and King Og's bedstead $13\frac{1}{2}$ feet long and six feet wide. The width across the hand at the knuckles was the 'palm', about three inches, and the thickness of a finger was the 'digit', of which about four make a palm, or instead of a finger

¹ Deuteronomy iii, 11.

sometimes men used the thumb's breadth, which later became the inch (Plate VI).

Men used their arms and hands to measure with long before they thought of using their feet, but with the Greeks and Romans the 'foot' became the chief measure of length. The Greeks also used the distance between the fingertips of the two hands when both arms are outstretched, which in a well-proportioned man is practically the same as his height. There is a Greek bas-relief in existence showing a man standing measuring thus with his arms outstretched (Plate IV), and this is the original meaning of our English 'fathom', which is now used only for depths.

Longer distances would be reckoned as so many 'paces', and the Scouts' pace of to-day is five feet, just like the Roman one which was the distance between two successive positions of the same heel, that is, a double step by first one foot and then the other. We sometimes nowadays 'step out' a room or carpet to see how long it is, and, taking a good stride, reckon each stride as a yard or a double step as six feet; a stride like this is naturally longer than the step which the Roman legions kept up while marching. Distances might also be described as so many stone's throws or spearcasts away. The Greek length, the *στάδιον* ('stadium' in our alphabet, and from which our word stadium comes), was supposed to be the distance a man could run at full speed without slackening. The 220 yards race is the longest of our athletic races which can be run so, and the Greek 'stadion' was rather less than this. The Hindus had a length known as a 'breath', with the same idea behind it.

Long distances would probably be described in terms of the length of time taken to travel. American Indians

used to say so many 'suns away', meaning so many days' 'journey', to describe how far off some place was when describing it to settlers. Signposts, even nowadays, in Switzerland and other mountainous countries often have written on them, alongside the name of a place, not how far away it is, but how many hours' walking by an average person is needed to get there. And we often see advertisements describing houses as 'Ten minutes from the station' in our own papers, or are told by seaside hotelkeepers that their hotels are only 'Two minutes from the sea'. The word 'journey' itself, derived from the French word 'jour', meant originally the distance one could travel in a day.

For capacity, perhaps the earliest measure of all would be the handful. 'Who hath measured the waters in the hollow of his hand and meted out heaven with the span', said Isaiah¹ of Jehovah. Gourds and coconuts and birds' eggs would also suggest themselves as convenient for holding grain or liquids, and would form a rough series of varying sizes.

For weighing, grains supplied the earliest counterpoises; grains of wheat were used to weigh other things by the famous King Hammurabi of Babylon as early as 2000 B.C.; the Greeks used barleycorns and the Chinese used mace in the same way. As at first only precious metals seem to have been weighed, this would not entail so much counting of grains as might be thought. The weight of the English penny was defined in the thirteenth century by saying that it was to weigh as much as '32 grains of wheat, dry and taken from the middle of the ear'; and 24 grains (i.e. barley)=1 pennyweight is still part of our troy table of weight, though no longer the

¹ Isaiah xl, 12.

weight of pennies. And if it no longer tests coins by weighing them against grains, the Mint still states the proper weight for each coin in this way—a halfpenny, for instance, should weigh $87\frac{1}{2}$ grains. The 'carat', too, used in connection with gold and diamonds, is really a seed, for the word is a corruption of the word 'karob', the bean of an Abyssinian tree.

But all these primitive ways of measuring that have been mentioned are at best inaccurate and uncertain—coconuts and grains of wheat are not all the same size and the length of men's arms and the span of their fingers vary. Gradually a desire for greater exactitude grew, and then instead of each man using his own forearm, the arm of some Royal personage was probably taken as the standard cubit, just as our yard is said to be the length of the arm of Henry I.

A modern instance occurred in 1865, when Queen Raoqherina of Madagascar decreed that all palaces and public buildings in future were to be built using a unit called The Queen's Arms. As this was five feet eight inches long it must have been the distance between her outstretched fingertips.

Greater uniformity in measuring liquids would be acquired by primitive men when the art of making pottery had been mastered, by making vessels to hold definite quantities of grain or water; and stones would be chipped or lumps of metal cast so as to provide standard weights for use as counterpoises in the scales.

We are able to find out quite a lot about the weights and measures of ancient races. The giving of a receipt for payment of purchases took place even when it was written on a clay tablet instead of paper, and these and

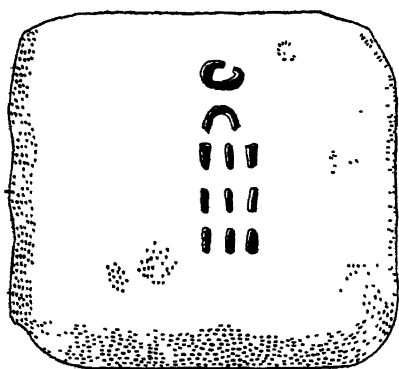


Fig. 4.—An Egyptian alabaster weight inscribed as weighing 19 gold units. The crescent at the top is the symbol for gold; \cap stood for ten and each stroke for one.

other records of business transactions have survived. Old books, too, such as works on medicine, often mention the measures in use.

Sometimes carpenters or masons lost their rules during building operations—a two-cubit rule was found in the walls of the famous temple of Karnak in Egypt when it was explored and is now in the British

Museum and is one of the oldest measures in existence. Metal weights stamped with their value or vessels marked with their contents have been unearthed. A statue dug up at Gudea in Babylon dating from about 2500 B.C. and now in the Louvre shows the king seated with the plan of a palace across his knees and a scale alongside the plan, and from this and a clay tablet dug up at another place called Senkereh giving multiples and fractions of a cubit, we can reconstruct the Babylonian way of measuring lengths.

When there is no direct evidence, use can be made of the fact that in most buildings the length and breadth not only of floors but also of doors and windows are either a whole number of feet, or whatever unit is used instead, or easy fractions of the unit length, because before erecting buildings, in olden days as now, a plan must be made, and it is natural to make the measurements either whole numbers or halves or quarters. Men known as metrol-

gists (i.e., scientific measurers, and quite different from meteorologists, who deal with the weather) take all the measurements of an ancient building and, by finding some length which will divide easily into all these measurements, reconstruct the unit length by means of which that building was built. Weights, too, were made in sets of easy multiples, like our $\frac{1}{4}$ lb., $\frac{1}{2}$ lb., 1 lb., 2 lb., 4 lb., and from those dug up the unit used for weighing can be ascertained.

It appears that there was considerable uniformity over all the ancient world. There was a unit of weight used for weighing gold and other precious metals and it is suggested that this arose in the very early days when metals were first used as the medium of exchange instead of trade being conducted by barter, and that it represents the value in gold of an ox. (See also Fig. 1, p. 15.) Before money was invented, most of the races who kept cattle used to express the value of other things in terms of cattle, and the fact that many early weights are in the shape of ox heads or hides lends support to the idea that the earliest unit of weight was the weight of gold that was the price of an ox.

As the chief unit for measuring length, the cubit was used very extensively all over the ancient world. But when we talk of uniformity in ancient times we must not think of or expect the uniformity such as all our yard-measures or foot-rules have; all that is certain is that many different races used as their chief measure of length a standard which was roughly the length of the human forearm. Actually the cubit varied in different places and at different times from seventeen to twenty-seven inches: it makes several inches difference, for instance, whether you measure to the tip of your middle finger with your

hand open, or to the end of your knuckle with your hand closed. But if we consider that there was nothing to prevent men taking any length whatsoever as their standard and building up a table by multiplying or dividing it, it must be more than an accident that most of the early civilisations agreed in using the approximate length of the human forearm.

The use of the same weights and measures is spread among nations mainly in two ways; either by conquest, for even if the conquerors do not insist on their subjects giving up their old standards, they are probably more advanced in civilisation, and after conquest the primitive people they have subjugated will be brought into closer contact with them and their ways of life, and may, realising the advantages of a better system of weighing and measuring adopt those used by their new rulers—or, more often, it is through trade that the standards spread. Obviously it simplifies trade enormously if buyer and seller both use the same standards, and a people who begin to trade with another race which has a superior method may give up their old standards in favour of better ones, or use them along with their own.

Along the great trading routes that linked the centres of civilisation in the Tigris and Euphrates valleys with those bordering the Mediterranean through Asia Minor or through Egypt and Cyprus, the weights and measures of Babylonia travelled west and came to Greece. Greek traders carried them farther west to Italy, Gaul, and Spain. The weights and measures of Rome were spread with her conquests throughout the Roman Empire, and so reached Britain. But some of our measures we derive not from Rome, but from our Anglo-Saxon ancestors, and exactly whence these originated is lost in the mists of time.

Chapter II

MEASURES OF LENGTH

Most of our present units and tables are very ancient. In a law of King Athelstan (A.D. 924-940) many of our familiar terms appear. "Thus far shall the King's Peace (i.e., sanctuary) extend from his dwelling—iii miles and iii furlongs and iii acres' breadths and ix feet and ix palms and ix barleycorns'.

The foot, as has been said, became popular in ancient Greece, but the actual length varied considerably. The foot used to build the Parthenon at Athens was about one-eighth of an inch less than ours; we know this because the Greeks called the main hall 'The Hundred-Foot Hall', and it is not quite a hundred of our feet in length. The Roman foot was only about $11\frac{2}{3}$ of our inches; the diameter of the circle of stone at Stonehenge is just a hundred of these feet. But measurements of other circles and of ancient churches in this country show that often a foot of about $13\frac{1}{3}$ inches was the one used in building them. This large 'foot' was used by Germanic tribes and may have been taken from the feet of a bigger and taller race than the Romans. It was not until the fifteenth century that the present length became the settled one for the standard foot (Plate VII).

But though the Roman foot was not quite as long as ours, it was divided into twelve parts, called 'unciae' from which our word 'inch' comes. On the body the inch is sometimes thought of as the thumb's breadth or the distance between tip and first joint. The directions

said to have been given by King David of Scotland in the twelfth century for the standardisation of the inch were that it was to be the average width of 'the thowmys (thumbs) of iii men, that is to say a mekill (tall) man, and a man of measurabill statur and of a lytell man. The thoums are to be messurit at the rut (root) of the nayll (nail)'.

The 'yard' cannot be traced back beyond Saxon days, but it is probably a double cubit or ell (twice eighteen inches). Tradition (as has been said already) says that the first attempt to fix its length exactly was when it was ordered to be the length of Henry I's arm (from neck to fingertips presumably); and women still estimate a yard of material roughly by 'nosing' it, taking the distance from the end of their noses to their fingertips. The word is derived from an Anglo-Saxon one meaning a piece of wood (as in the yardarm of a ship) and it was used for a herdsman's goad, which would be a handy object for measuring if required. Sometimes of old the yard was regarded as the distance round a man's body (not a Victorian lady with an eighteen-inch waist!). There is another Anglo-Saxon word from which the word 'girth' is derived, and also the word 'yard' when it means an enclosure as in 'backyard'; so perhaps this association of the yard with the human body is as ancient as its origin with the herdsman (Plate VII).

Another curious bit of history is a law passed by Henry IV that the yard should be thirty-six inches and a thumb's breadth, the reason being that when material was being cut with scissors in the right hand, both material and measuring rod had to be held in the left between the thumb and fingers. It was easy for a fraudulent merchant to make the cut on the wrong side of his

thumb and so deprive the buyer of a thumb's breadth of his due. But if his yardstick was thirty-seven inches long, if he cut on the near side he would still give his customer a full yard. This law remained in force for over 100 years. In the old house at Jedburgh where Mary Queen of Scots stayed there is a collection of old measures and among them an old Scottish yard with a thumb's breadth at each end.

How fond mankind is of halves and quarters is shown by the persistence of the use of fractions of a yard alongside of feet. We all buy dress material this way, probably because halves and quarters can be obtained by folding much more easily than thirds, and materials are made up in nine-inch, twenty-seven inch, and fifty-four inch widths, that is, $\frac{1}{4}$, $\frac{3}{4}$, or $1\frac{1}{2}$ yards. The standard size for bricks is 9 inches by $4\frac{1}{2}$ inches by 3 inches (actually a little less to allow for the space taken up by the mortar), which is probably a relic of a similar idea, for the measurements are $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$ of the old eighteen-inch ell. Carpenters also stick to the use of fractions of inches in preference to decimals and go down from $\frac{1}{2}$ and $\frac{1}{4}$ to $\frac{1}{8}$, $\frac{1}{16}$, and even $\frac{1}{32}$ of an inch.

The 'Statute for Measuring Land', which is probably one of Edward I's laws, though the date is not certain, is the earliest to give the table with which we are all so familiar. 'Be it remembered that the Iron Yard of our Lord the King containeth 3 feet and no more. And a foot ought to contain 12 inches'. Some old copies of the statute also add 'It is ordained that three grains of barley, dry and round, do make an inch'. There is a relic of this, perhaps, in shoe sizes; in men's shoes, for instance, a No. 8 is eleven inches long, a No 9 $11\frac{1}{3}$ inches, a No. 10 $11\frac{2}{3}$ inches, the sizes increasing by one-third of an inch,

or a barleycorn. Some old table-books go even lower than the barleycorn, and give twelve hairs-breadths=one poppy-seed; four poppy-seeds=one barleycorn.

The 'Statute for Measuring Land' went on: 'Five yards and a half make one Perch, that is sixteen and a half feet, measured by the aforesaid Iron Yard of our Lord the King'. This (the rod, pole, or perch) was the smallest of the ancient measures for land, which grew up quite independently of the units used for cloth and for buildings; when the cloth and land measures were united into one table this awkward fraction had to be used to bridge the gap. In spite of this law and a repetition by Elizabeth I, the rod varied considerably in different parts of England and at different times, and was not really fixed until the Weights and Measures Act of 1824.

It must have got its name from a much longer stick than the herdsman's goad; it may have been the yoke-pole of a team of eight oxen in pairs four abreast which was the normal team of Anglo-Saxon days, each of four men contributing a pair of oxen to the common team for ploughing. In Germany in the sixteenth century it was defined thus: Any sixteen men were to be told to stop as they left church on Sunday morning and were to be made to line up with their left feet one behind the other. The total length of their sixteen feet was to be the lawful rod. The rod is generally nowadays left out of the tables learnt at school, which go straight from yards to miles, but it is still used by builders. A rod of brickwork is $16\frac{1}{2}$ feet by $16\frac{1}{2}$ feet by $1\frac{1}{2}$ bricks thick. The word 'perch' is an abbreviation of the Latin 'pertica', a rod, though to modern ears it chiefly suggests a birdcage (Plate VII).

The modern name of the chain hides its antiquity, for it has been a measure since Anglo-Saxon times. The use

of a folding metal chain with a hundred links was suggested to surveyors by Professor Edmund Gunter in the seventeenth century and it has been used ever since. Before then, ropes with knots at intervals were used; the hieroglyphic sign for a hundred cubits in the Egyptian language was a coil of rope. When the prophet Ezekiel relates his vision of the new temple to be built in Jerusalem, he says an angel appeared 'with a line of flax in his hand and a measuring reed'¹—that is, with the ancient equivalents of our chain and rod.

The old name of the chain is used in the law of King Athelstan quoted earlier—the acre's breadth, which will be explained later. It is, as most boys know, the length of a cricket pitch.

The 'furlong' shows its own origin, being an abbreviation of 'furrow-long'. Horse or ox must have a pause for breath after the plough has been pulled a certain distance, and this is about the same distance that a man can run at full speed without pausing, so by both animals and human beings some such length was marked out by nature as a unit, and it gave the Greeks their 'stadion' and to us our 'furlong'. The Romans took over the stadion from the Greeks and reckoned eight of them in their land mile, as we have eight furlongs to our mile.

The mile is Roman in origin—'mille passus'—a thousand paces—two thousand steps—about 5,000 feet. Many of the 'mile-castles' that were built at intervals of every Roman mile along Hadrian's Wall from the Solway to the Tyne still remain. Measuring the distance between them, or between Roman milestones that are still in position, verifies that the Roman mile was considerably shorter than ours (about 1,618 yards). After the Romans

¹ Ezekiel xl, 3.

left, no milestones were put up until the seventeenth century. When coaches came into use, so many disputes and accusations of overcharging occurred that gradually milestones were placed along the turnpike roads, but they were not quite the same distance apart in some parts of the country as in others. The Act for the Establishment of Uniform Weights and Measures in 1824 finally fixed the length of a mile, though as long before as 1592 Queen Elizabeth I, in an attempt to keep a 'Green Belt' round London, had decreed that no one might enclose or build on any common or fields within three miles of any gate of the city, and added: 'To avoide Doubts that may arise. A Myle is to conteyne Eight Furlongs, and everie Furlonge to conteyne Fortie Luggs or Poles, and every Lugg or Pole to conteyne Sixtene Foote and Halfe', which gave the mile its modern value. But people still tended to think of a distance in terms of the time it would take them to travel. John Ogilby, map-maker to Charles II, made the first systematic measurements of distances between towns and issued a *Traveller's Guide* in 1675, but when the distances given in it are compared with modern measurements it is clear that his miles are shorter in rough country, that is, a distance along a rough road will be given by Ogilby as being more miles than the same distance along a main road where the going was easier. The Chinese still do this, a 'li' is longer on easy roads, and the journey from a village into town, if down-hill, is said to be shorter than the return trip home.

Anyone who goes to see 'Killarney's Lakes and Isles' must be wary if on foot and not a good walker, for the Irish mile is still used in some parts of the country, and, as it is 2,240 yards, when a signpost gives the distance to a place as eleven miles, it is fourteen by English

reckoning. There used to be a Scotch mile too, also longer than the English one, but that has gone out of use.

For all nautical purposes a different mile is used—the sea-mile—and there is more sense in this than appears at first sight. The navigator finds his latitude and longitude from the sun and stars, and then wants to find the distance he has sailed or the speed of the ship. A change in latitude of one degree means a journey of about sixty-nine miles (because that is what the circumference of the earth divided by 360 comes to) and each degree is divided into sixty minutes, each representing $\frac{1}{60}$ or $1\frac{5}{6}$ miles—a nasty fraction to have perpetually occurring in calculations. But if you call this distance one mile instead of $1\frac{5}{6}$, then each degree corresponds to sixty such miles, and as this is the number of minutes in an hour, calculations of speed as well as distance are made easier. Also this ‘sea-mile’ turns out to be so near to 6,000 feet that for practical purposes it can be divided into ten cable-lengths of 100 fathoms of six feet, and what a saving of arithmetic there is then!

The ‘league’—of which we all heard in our youthful days in *The Seven-League Boots* and in *The Charge of the Light Brigade*—‘Half a league onward’—is an ancient measure, and is supposed to be the distance a man can see on a level plain—about three miles. But it has never been fixed by law and nowadays is only used poetically.

Chapter III

MEASURES OF WEIGHT

LET us next see whence we have acquired our units of weight. Everyone knows that the abbreviation for pound—'lb.'—is the first and third letters of the Roman 'libra', of which it is a direct descendant. The Roman libra in its turn was about the same as a weight used by the Egyptians and another used by the Babylonians. It became the standard for weighing all over the Roman Empire. As the verb 'librare' meant to poise, it may have originally been the weight a man could poise or hold on his hand with his arm stiffly stretched. Before the introduction of the metric system, practically every country of Europe had a weight with a name derived either from the word 'libra' or from 'pondus', a weight, from which 'pound' comes. Spaniards and Portuguese still use the word 'libra' for one of their weights, and the French have a 'livre' and the Italians a 'libbra'.

Probably the original libra was a bar of metal a foot long divided into twelve inches or ounces, for the Latin word 'uncia' was used for a twelfth of a foot, or a twelfth of a pound, and both our words 'inch' and 'ounce' come from it. There are still twelve ounces to the pound in the troy table to match the twelve inches in a foot.

Perhaps it seems surprising, but from the evidence we possess it is clear that many ancient races including the Romans had two different systems of weights in use at the same time, as the inhabitants of Britain had from Anglo-Saxon days. In the Bible, describing the long hair

of King David's son Absalom, the writer of II Samuel says 'when he polled (i.e., shaved) his head, he weighed the hair of his head at two hundred shekels *after the king's weight*', showing that the Jews had two different systems, the common one and the royal.

It has been suggested that the use of a different standard for precious metals than for merchandise and bulky goods has its origin in the paying of tribute. If when the king received his tribute, in days when this was paid in kind, it was weighed by the heavier weight, but when he paid money out of his treasury he used the lesser weight, he naturally gained considerably. Sometimes, and in England till 1527, there has been a different system in use for coins than that for metal in bullion form. This probably became the custom because people used to bring gold and silver to the Mint to be made into coins and returned to them; if this bullion was weighed and found to balance a certain number of pound-weights and if the owner was given back coins that balanced the same number of pound-weights, but different and lighter pound-weights, the Mint would make some profit in return for the trouble of minting the coins.

But why *weigh* coins when giving them out instead of counting? The answer has been given in Part I: the custom of pricing all sorts of commodities by estimating the weight of gold or silver that men would give in exchange is centuries older than coinage, and persisted for centuries after coins were in general use (Plate V).

An English law known as The Assize of Weights and Measures (probably made by Edward I, though the date is uncertain) ran as follows: 'The Pound of Pence, Spices, and Apothecaries' Goods consisteth in the weight of twenty shillings, but the pound of all other things

weigheth twenty-five shillings . . . and the pound of pence contains 12 ounces. In the case of all other things the pound contains 15 ounces.' This is interesting because it shows that there were two different pounds in those days, the money pound and the merchants' pound (one of twelve and the other of fifteen ounces), and because it gives our familiar twenty shillings to the (money) pound. But it also shows that shillings and pence were thought of as weights at that time. A similar instance was given on page 18 in Part I.

Because of the very inferior state of the coins until the invention of 'milling', the habit of weighing coins, and insisting on receiving a certain weight of metal rather than a certain number of coins, persisted in England right down to the times of the Stuarts. Until only a few years ago this was the regular custom in China; if a traveller wanted to change a piece of silver into copper cash, the exchange would be made by weight.

The troy pound and the avoirdupois pound both came to us from France and ousted the earlier weights; after the wars in which the battles of Crécy and Poitiers were fought, there was much more intercourse and trade with the French, and the use of the same weights was a convenience. The term 'troy' is said to come from the city of Troyes in France, though some authorities prefer to connect it with an old English word meaning a balance, and say that the tron-gate in Edinburgh comes from the same word, and was the place where weighing in the balance took place, i.e., the market. Avoirdupois is French, though the first part is not from 'avoir', 'to have', but 'aver', an old word for goods; 'pois' means 'weight' (as in poise and counterpoise), and the whole word means

'goods of weight', i.e., it is the method used in weighing heavy goods.

The earliest record of the word being used is in the reign of Edward III, but it was not a pound of sixteen ounces till later, and it was not until 1532 that its use was sanctioned by law. A law passed then says: 'Carcasses of Beoffes, porke, mutton or veale shall be sold by the weight called Haberdepayes', and it continues: 'and no person shall take for a pound of beoffe or porke above one halfpenny nor for a pound of mutton or veale above one halfpenny and half-farthing'—which gives another instance of the change in prices since those days.

Both avoirdupois and troy pounds were used side by side till 1878, when the troy pound was abolished, and it was decreed that except for retail drugs (which are sold by apothecaries' measure) 'all articles sold by weight shall be sold by avoirdupois weight, except that gold, silver and articles made thereof, including gold and silver thread, lace or fringe, also platinum, diamonds, and other precious metals or stones may be sold by the ounce troy or by any decimal part of such ounce', with the curious result that while we have now only one legal pound, we have still two legal ounces, one of 480 grains (from the troy table: 24 grains=1 pennyweight, 20 pennyweights=1 ounce) and the other of $437\frac{1}{2}$ grains, i.e., one-sixteenth of 7,000 grains, which is the legal value of the avoirdupois pound. Apothecaries' measure is used by chemists and by doctors in prescriptions and the apothecaries' ounce is the same as the troy one, but for liquids the pharmacist uses the avoirdupois ounce and rechristens it a 'fluid ounce'. However, of late years the use of the metric system for medicines instead of either has been increasing steadily.

The whole subject of weighing gives us a sidelight on English history; while we got the words 'pound' and 'ounce' from Latin, in adopting sixteen ounces to the pound we are following the customs of the more northerly parts of Europe; while the usual abbreviation for ounce—oz.—is the first and third letters of the Italian 'onza' (which like 'ounce' came from the Latin 'uncia') and dates from the fifteenth century, when Venice and other Italian cities were the greatest centres of trade. English merchants copied in their account books the headings lb. and oz. which the Italian merchants used, and have done so ever since.

As to the heavier weights we use, the 'stone' speaks for itself as an ancient unit—what would be more natural than to pick up stones and use them for weighing things that were too bulky to weigh against grains? But stones are of all shapes and sizes, and the 'stone' remained a most uncertain and variable unit down to recent times. The Smithfield stone of eight pounds was used for meat by butchers till it was forbidden in 1939. The stone of fourteen pounds is first mentioned in one of Edward III's laws which decrees that this is to be used for weighing wool.

The half- and quarter-stone are used in some parts for potatoes and flour; a visitor to the Midlands asking for a two-pound bag of flour might be surprised to be told that the nearest size made up ready for sale was $1\frac{3}{4}$ pounds, but it is only another instance of the advantages of using $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{8}$ in measuring. A sack of flour containing a stone can be put on one side of a balance and out of it an empty bag on the other side can be filled till the two balance, then each of these bags can be halved, and halved again, without the trouble of using weights.

The Romans had a hundredweight—the ‘centum pondium’—100 times as heavy as the libra. Our hundredweight, of course, began as 100 pounds and its altered value is a result of the frequent tendency in trade to throw in make-weight; thirteen buns to the baker’s dozen, for instance, or the wholesale ‘hundred’ of eggs which is 120. There is some justice in this custom when goods are bought in bulk to be sold in smaller quantities, for if a grocer bought 100 pounds of sugar and weighed it out into separate pound bags, the little extra needed to tip the scales every time would be enough to make it impossible for him to fill 100 bags. Garage proprietors under various schemes of rationing petrol were allowed a fresh supply of 100 gallons for every ninety-nine coupons handed in by them, for even with automatic pumps there is bound to be a little wastage, which adds up to an appreciable amount in course of time.

If different suppliers of a commodity offer differing ‘make-weights’ there is naturally competition and confusion. As early as the reign of Elizabeth I the extra to be thrown in with 100 pounds became fixed as twelve pounds, and so the hundredweight became 112 pounds. The quarter had, of course, to follow suit and change from twenty-five to twenty-eight pounds. A weight called a ‘cental’, really 100 pounds-weight, was added in 1879 to those which could be legally used in Great Britain to make easier trade with America, which uses the pound but rarely the hundredweight and quarter. The cental and half-cental of fifty pounds are coming more and more into use in trade, but the hundredweight of 112 pounds has one advantage because it can be divided in a great many different ways—112 has eight factors, 2, 4, 7, 8, 14, 16, 28, 56, while 100 only has five.

Our largest unit, the ton, was spelt 'tun' till a hundred and fifty years ago. The 'tun' is still used in the wine and spirit trade with the meaning of a large and heavy cask, and the name is said to come from the thundering sound made when the empty cask is hit, cf. French 'tonnerre' (thunder). From the wine trade the original meaning has been extended to a heavy load of any substance. The 'tonnage' of ships was originally the number of tuns of Bordeaux wine that the ship could carry in the wine trade from France to England. In most of the colonies and the United States the ton is 2,000 pounds and not 2,240, and when doing business, if there is any fear of confusion, they call theirs the 'short' and ours the 'long' ton.

The use of a balance for weighing must be at least five thousand years old, for we have wall paintings of ancient Egyptians weighing, and weights used by the inhabitants of Nineveh have been dug up. In the poems of Homer there are references to weighing wool, and the amount given out to a female slave to spin was weighed to see that she returned it all and did not steal any.

The steelyard was invented as an alternative mechanism and was very popular with the Romans. Its name shows the word 'yard' with its early meaning, for it is merely a steel stick or bar, with a sliding weight and a fixed support (Plate IV). The principle is that used on the machines for weighing luggage and goods at railway stations, with a platform for the goods and a small movable weight sliding along an arm. One form also popular in England in early days was forbidden in 1350 because it was easier to defraud with it than with scales. Now the scales in their turn are being ousted more and more by the machine with a dial for registering the weight, with which we are all familiar in shops.

Chapter IV

MEASURES OF CAPACITY

MEASURING goods by their bulk seems to have been an idea that came later to mankind than weighing; there are some Asiatic tribes even now who have no measures of capacity. But as soon as man invented pottery, he must have been able to replace the eggs and coconuts he had used before to hold liquids and grain by jars and bowls; and to make these in standard sizes does not seem a very big advance for a primitive race to take. But the fact that the same weight of different substances would not take up the same space was one that was only realised very slowly.

In the Assize of Weights and Measures, referred to before on page 77, there is the earliest definition of a gallon—‘8 pounds of wheat make a gallon of wine’, that is to say, a gallon of wine takes up as much space as eight pounds’ weight of wheat.

The original pint was a vessel that held a pound weight of grain. ‘A pint is a pound all the year round’, runs an old saying, and this is nearly true of most grains, but not of other things, and we are more familiar with another saying: ‘A pint of water weighs a pound and a quarter.’ The result of this uncertainty about different substances was that before The Weights and Measures Act of 1824 there were several gallons in existence—a corn gallon, a wine gallon, and yet another for ale and beer, and for coal a bushel was used that was not eight times any of these gallons. One lasting result of this diversity is that

if the owner of an English car with a petrol tank holding eight gallons, say, took his car to the United States and bought eight gallons (he would have to ask for 'gasoline', not petrol) he might think he was being defrauded, as his tank would not be full. The American gallon for liquids is still the wine gallon of Queen Anne's reign, abolished here in 1824 (Plate X), and only about five-sixths of our present gallon.

Our capacity table, with its twos and fours and eights, makes it easy to get one measure from another by filling up a smaller vessel repeatedly and emptying it into a larger; it probably comes to us from Teutonic tribes who were given to doubling in their tables, as in the sixteen-ounce pound ($16 = 2 \times 2 \times 2 \times 2$), which, as before-said, we owe to northern neighbours.

The word 'gallon' originally meant merely a vessel or bowl, and the quarter-gallon has become abbreviated to 'quart'. The pint is almost the same size as an old Roman measure, and is about as much as a thirsty worker can drink off at one drain. The most likely derivation of the word is from 'pinta', a mark, that is, a mark made on the side of a larger vessel to show the level to which to fill it with one or more pints, as our saucepans and jugs are sometimes marked. The word 'gill' is perhaps a pet name, an abbreviation of the Christian name Giles or Gillian, like a burglar's 'jemmy', or calling all donkeys 'Neddy'. Giving human names to familiar objects seems to be a persistent habit of mankind. The gill is still often reckoned as half a pint in the north of England in spite of the legalising of the southern custom of using the term for a quarter of a pint.

'Bushel' is from the Old French 'boissel', a wooden box, to which the modern French word 'boîte', a box, is akin.

It was evidently some sort of receptacle to hold the grain. 'Peck' is the same word that we use in speaking of fowls 'pecking' food or in feeling 'peckish' ourselves, and probably meant originally an allowance of corn or other food to eat.

In many arithmetic books the last item in the capacity table is 8 bushels=1 quarter, and it may have occurred to some of us to wonder—a quarter of what? It may be a quarter of a large measure known as a chaldron, which was till 1889 used for coal, but this has been thirty-six bushels, and not thirty-two, since the fourteenth century, and even Magna Carta speaks of the 'London quarter' not as a quarter of anything else. Perhaps it was never a quarter of anything like the quart and the quarter in the weight table, but was just a name for a large quantity of corn and may be derived from the same root as the words 'quern' and 'garner'.

For liquids, measuring by capacity is the easiest way, but for dry goods there are some serious disadvantages. A considerable difference can be made to the quantity a can or basket will hold by shaking down the contents, and when it is filled, for instance, with grain poured in, this will rise in a rough cone in the centre above the level of the edge. The buyer may consider this cone to be part of his canful, the seller will want to level it off. Cookery recipes nowadays find it advisable to distinguish between a 'heaped tablespoonful' and a 'level tablespoonful' of an ingredient, whereas the doctor need make no such distinction about our doses of medicine. Endless disputes took place and led to repeated legislation as to whether goods should be sold by 'heaped' measure, that is, with this cone included as part of the quantity supplied, or by 'strike', in which the seller might strike off the upstanding

part with a ruler or stick until the surface was level. In 1597, for instance, there was a big dispute between the County of Cheshire and the Town of Lymm, in which the townsfolk of Lymm declared that corn had been sold there 'by a bussell stryked with a rowle (ruler) as nowe it is, tyme without memory' and refused to alter their ways. Till 1835, when 'heaped' measure was abolished, such goods as coal, fish, potatoes, and turnips were sold with the 'heap' included.

The general tendency has been to increase the number of things that must legally be sold by weight, and so avoid these irregularities. Wheat may be bought by the quarter but bread must be sold by weight; coal, unless sold by the bag, must be weighed, and most of our purchases at grocers and greengrocers are weighed for us, or packed in standard weights. Several Government orders of recent years have dealt with this matter; bananas and oranges can now be sold by weight—a much fairer method of selling them than at so much each, as sizes differ considerably. Cabbages and other greens used to be sold by the shopkeeper putting a price on each cabbage, and the customer judging by eye whether he thought the price a just one; now they may be weighed and sold at so much per pound. Eggs too must be graded by weight, and the prices are fixed accordingly.

Capacity is still used, however, in various trades; tea is sold by the chest, hops by the sack, and the 'cran' of herrings is a basket of a certain size. In some parts of the country, strawberries are still sold by the pint, shrimps by the gill, bulb fibre by the quart, and so on.

In the market at Cambridge till comparatively recently butter was sold by the yard, in a long thin roll.

This sounds odd, but actually was done for the convenience of customers, for college butlers had to divide the butter into small portions known as 'sizes' to supply individual students, and it was easy to make the sizes equal by cutting off small equal lengths. Obviously unless the yard of butter was also weighed, the thickness of the roll might vary and so fraud might creep in.

Chocolate boxes often contain little tickets to tell us that their contents are of 'net weight $\frac{1}{2}$ lb.' and the wrappers of packets of tea and other goods often bear the same words. An Act passed in 1926 ordered this to be done where goods were packed previously to save weighing in the shop. There has lately been considerable discussion in Parliament about the discrepancy that still exists and a new legislation is likely to safeguard the housewife still further.

But packets of potato crisps are merely marked so many pence a packet, and biscuits are sometimes packed in twopenny or sixpenny packets bearing no statement of their weight, nor do cafés print on their menu cards how many cubic inches the 'pot of tea 1/-' holds. There have been cases of dispute which have been taken into the law courts, but the judges upheld that in certain cases the customer is buying by eyesight and not by measure, and must judge for himself whether he is willing to pay the price asked. If the number of biscuits in the packet is found to be few, the remedy is to refuse to buy that kind again; while if the teapot is small one must ask for more hot water.

Chapter V

MEASURES OF AREA AND VOLUME

MEASURING area is not nearly as simple as measuring length. To measure a length, you have only to take your foot-rule or yard-measure and put it down over and over again, that is, you need to be able to count; but to find the area of even the simplest shapes, a square or rectangle, you need to be able to multiply—a much more advanced process in arithmetic. Multiplying two big numbers together was in fact almost impossible until our method of writing numbers came into use; anyone who tries to do a multiplication sum in Roman numerals will realise this, and yet it is only four or five hundred years since our figures drove them out of common use.

One of the earliest ways of estimating the area of a piece of land was to say how much seed would be needed to plant it. This was the method used by the Babylonians, and the Jews have the same word (a 'homer') as a unit of capacity for grain and as a unit of area for land, so that it must have had a similar origin. A rough-and-ready way of estimating the size of a farm was to count the number of ploughs needed to cultivate the land or the number of yoke of oxen employed, and these made a convenient basis for levying taxes as in Domesday Book. The Romans took as their unit of size the amount of land that a pair of oxen could plough in a day, and this is the origin of our acre; the word is derived from the Latin 'ager', a field, which has, of course, given us also the word 'agriculture'.

At first the acre was a definite shape, due to the Anglo-Saxon custom of dividing land into strips for cultivation. The original acre was a furlong in length so that the plough went from one end to the other without turning, and was one-tenth as wide. This same shape, ten times as long as wide, was common on the other side of the English Channel too at the same period. Like all other measures, the acre varied considerably in olden times; a forest acre would be larger than an acre of farmland, for instance; the underlying idea being that as the land was less profitable, more of it should be taken into account.

The furlong being 220 yards, the size of the standard acre was 220 yards by 22 yards, and the 'acre's breadth' is therefore the ancient equivalent of our modern chain, while the number 4,840 in our table for the number of square yards in an acre is 220×22 . The Statute for Measuring Land, referred to on page 71, gives a list of the breadth the acre must have when it is of various lengths; when it was ten perches long it should be sixteen in breadth; when it was eleven perches long its width should be $14\frac{1}{2}$ perches and $\frac{3}{4}$ foot and so on—so that by this time the acre was losing its fixed shape, but it was thought necessary to state in a law results that anyone nowadays could get by simple arithmetic.

It is because it began as a strip that the acre is not the square of any of our units of distance and is still an oddity in our present area table among the square inches, square feet, etc.

The value of adding '10 square chains=1 acre' as a relation in our tables is not always appreciated; it allows decimal methods to be applied to area, e.g., a field fifteen chains seventy-five links by six chains thirty-two links has as area 15.75×6.32 square chains, or 99.54

square chains, which is 9.954 acres, or 9 acres $9\frac{1}{2}$ square chains (approx.).

When the ancient acre had to be divided, it was more convenient for ploughing to divide it lengthwise than the other way.



Fig. 5.—The width of the diagram represents 220 yards or 1 furlong, the depth 22 yards or 4 rods, and the shaded area, which is $5\frac{1}{2}$ yards or 1 rod deep, represents 1 rood.

The acre's breadth was four rods, so when divided into four the width of each strip was one rod, and this strip was also known as a rod or rood. When the boundary of the land was curved or irregular, it was still often divided into strips a rod wide, and so it was rather natural to talk of a rod of land as well as a rod of length. The yard was used too in the same double sense, and even down to the eighteenth century there was no such distinction between the foot and the square foot as teachers impress on their pupils when learning 'area' in arithmetic nowadays. This sum is taken from an arithmetic book called *The Gentleman and Tradesman's Compleat Assistant*, by J. Leadbetter, printed in 1769:

7 ft. 9 in. \times 3 ft. 6 in.			
f.	i.	p.	(p stands for parts)
7	9		length
3	6		breadth
<hr/>			
23	3		product by 3 ft.
3	10	6	ditto by 6 in.
<hr/>			
ft. 27	1	6	content

Method—9 in. \times 3 ft. makes 27 in., carry 2, 7 ft. \times 3 ft. makes 21 ft.
6 in. \times 9 in. makes 54 parts and so on.

Evidently in working this, numbers of feet and inches have been multiplied together, and the result is a number of inches; there are twelve inches in a foot for area as for length, and what we should call a 'square inch' is called a 'part'. It looks as if there were then worse evils than having to remember that 144 square inches make a square foot and not twelve! Of course, all our square units are comparatively modern; there was little occasion to measure small areas in olden days—if necessary they would be compared with familiar things, as Elijah's servant did, when sent to look for signs of rain after the slaughter of the priests of Baal on Mount Carmel: he returned and said he could see a cloud arising 'as small as a man's hand'. Square miles were unknown and unnecessary until the days of accurate surveying. Cubic inches and cubic feet as units for measuring volume are still more modern; the first mention of a cubic inch in a statute is in 1707. Builders still speak of a yard of sand or gravel when they mean a cubic yard of these substances.

Chapter VI

THE MAINTENANCE OF THE STANDARDS

ACCURACY in weighing and measuring has kept pace with the needs and increased skill of humanity. The ancient weights dug up, even allowing for possible loss of weight by long use, and for deterioration while buried, show far more variation than we should consider at all satisfactory; yet evidently there was a keen desire to have correct standards and encourage honest dealing. The Bible contains many injunctions to the Jews of this kind: 'Ye shall do no unrighteousness in judgment, in meteyard, in weight, or in measure.'¹ Kings considered it a part of their duties to see that standard weights and measures were made and distributed. Babylonian weights bear inscriptions such as 'one maneh, a duplicate of the weight which Nebuchadnezzar, King of Babylon, made in accordance with the deified weight of Dungi, a former King'. 'Deified' suggests that the Babylonians considered the maintenance of good standards a sacred matter. 'A just balance and scales are the Lord's: all the weights of the bag are his work',² sang the writer of Proverbs, as if he felt that the standard weights in use had been given to men as a divine gift. The Jewish standards were kept in the Temple at Jerusalem—the Romans kept theirs in a temple at Rome and in Christian times they have often been kept in churches; our English standards were kept in the Pyx Chapel at Westminster Abbey from after the Norman

¹ Leviticus xix, 35.

² Proverbs xvi, 11.

Conquest till Victorian times. There may have been some idea that the god of the shrine, or the bones of the saints in the sanctuary, would protect the standards from evil happenings, but there was also some realisation that honesty in trading is a matter of religion.

After the collapse of the Roman Empire, during the Dark Ages that followed, the weights and measures in use deteriorated sadly and there was a gradual return to the primitive ways of measuring with the human body. Practically every town had its own standards, differing from those of neighbouring towns, with perplexing results to trade, and the various trade guilds in the Middle Ages made, and sometimes kept as trade secrets, their own standards, which were often different from those of the same name used in other trades (Plate VIII).

The earliest law attempting to enforce the use of the same standards in England is one of King Edgar's (A.D. 959-975): 'And let one money pass through the King's Dominions and that let no man refuse; and let one measure and one weight pass, such as is observed at London and Winchester'. In Magna Carta the barons desired of King John that 'the measure of wine and corn and the widths of cloths and other things be made correct, and so also of weights'.

Guardians of weights and measures are said to have been appointed for every county, city, and borough by Richard I, and they were to keep iron 'ulne' (or yard measures) by which those in use in their neighbourhood could be tested. If there are different measures in use, traders can take unfair advantage by buying by one and selling by a shorter, and laws had to be passed to prohibit this. In China this is the customary method by which a trader makes his profit; the answer to the conundrum

'How does a Chinaman buy goods and sell them at the same price and yet make a profit?' is that, whereas our shop-keeper makes his profit by selling at a higher price per yard than he paid, the Chinaman charges the same price per 'pu' but the pu for selling is shorter than the pu for buying.

Our oldest standards still existing date from the reign of Henry VII, who in a law of 1495 decreed that: 'In every Cite Burgh and Towne shulde be a common balaunce with common weights and common mesures marked according to the Estandard of the Exchequer.' The Exchequer's standard yard—an eight-sided bar of brass—and the standard 'Winchester' bushel and gallon are now in the keeping of the Science Museum, South Kensington. Their name commemorates the fact that standard measures are said to have been kept at Winchester in the days when that was the capital of the kingdom of Wessex. The sets of weights made at the same time were destroyed by order when better standards were made by Queen Elizabeth I in 1588, but some of the copies which had been sent to counties and chief cities are still in existence, though when the new ones were sent out, instructions were issued that all older ones were to be 'damned and broken'. Queen Elizabeth's standards of 1588 were used from then until 1824. During this long period they naturally suffered a little from wear and handling, but are in sufficiently good condition to show that the yard and the pound are practically the same now as then: when we read in the official record of their construction that the weights were made to agree with a fifty-six-pound weight of Edward III which was in existence then though it has disappeared since, we realise how far back in the history of the English race our present system goes.

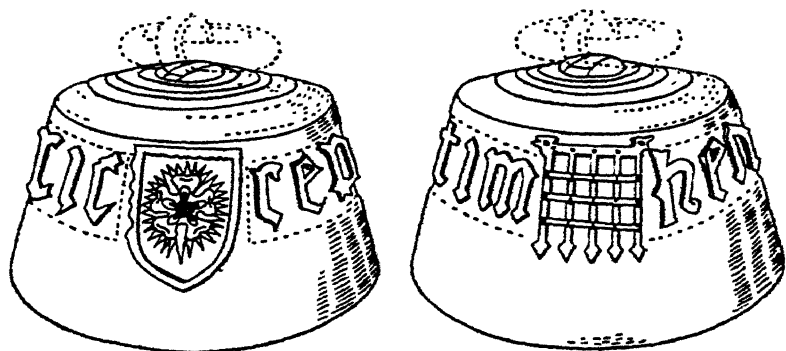


Fig. 6.—A copy of the standard 14-pound avoirdupois weight of Henry VII sent to Exeter and still in existence.

In 1824 new standards, which were named 'Imperial' standards, were constructed, but ten years later a great fire in the Houses of Parliament destroyed these standards, which had been housed there, and new ones had to be constructed. The chief Act on weights and measures is one of 1878 which decreed that every contract and sale must be made in terms of the Imperial weights and measures and that if a bargain mentioned others such as firkins, hobbits, or schooners, then that bargain was not legally binding and payment could not be enforced.

The two chief standards, legalized in 1855 and still in use, were also defined in this Act. They are the Imperial standard yard, the distance between the centres of two gold pins in a bronze bar, measured when the bar is at 62° Fahrenheit, and the Imperial standard pound-weight, the weight in a vacuum of a certain platinum cylinder. The Imperial standard gallon was defined as 'a vessel containing 10 pounds weight of distilled water weighed in air with the water and air at 62° Fahrenheit and the barometer at 30"'.

The refinements in these definitions are worth notice; if the yard and gallon were not measured at a definite temperature, the expansion of metal with heat, or contraction with cold, would affect the results; the weight of an object weighed in air varies slightly with the pressure of the air above it, hence the proviso about the barometer; and the impurities in undistilled water would increase the weight of water that a vessel would hold.

Because of the difficulties found in replacing the standards lost in the fire of 1834, four copies of the standard pound and yard (which are kept at the Board of Trade) were constructed and these are compared with the original ones every twenty years. The standards at the Board of Trade are kept under lock and key, and it needs three sets of keys, which are kept by three different officials, to unlock the safe where they lie.

From these fundamental standards others were constructed up to 100 feet in length and up to a fifty-six-pound weight and up to a bushel, and none but copies of these are lawful to use. There is a series of ounce weights, for instance, of one, two, four, and eight ounces, and it is illegal to use a three-ounce weight, for instance; any number of ounces up to fifteen can be built up with the four legal weights, and to have more would only lead to confusion and perhaps cheating. The largest units were not constructed because they would have been too heavy and awkward to be of practical use; so a hundredweight is merely a name, and to balance a hundredweight of coal two fifty-six-pound weights must be used, or others totalling 112 pounds.

The standard gallon (Plate X), made in 1824, has a diameter equal to its height, but the standards for dry measures have a diameter equal to double the height. The

point of making the standard measures of capacity a special *shape* as well as size is that a very tall deep vessel might have the same space inside it as a shallow wide one, but if they were both filled with grain, the tall deep one would be found to hold more, for the grain on top would compress that below; so if all shapes were allowed a man purchasing grain might bring narrow deep vessels to hold it, and he would get more than the standard measure.

The Act of 1878 also gave detailed instructions to each local authority in the country about the appointment and duties of inspectors of weights and measures. Not only do these inspectors examine the weights and measures used in shops and markets, from the tiny weights used by jewellers and chemists to weigh-bridges capable of weighing fifty tons; they have to verify all the $\frac{1}{2}$ -pint tumblers manufactured for use in public-houses, test automatic machines of all sorts, and stop coal carts and check the weighing of the loads of coals.

The National Physical Laboratory at Teddington also plays an important part in the maintenance of precision in trade and scientific work, for there all sorts of tests on materials and measuring instruments and hosts of other things are carried out.

Chapter VII

MODERN STANDARDS OF MEASUREMENT

THE vicar of a church at Lyons was the first to propose (in 1670) a complete metric system, that is, a system using tens and hundreds, etc., as the relation between various units, and with the units based on measurements of the earth. Some wiseacres have declared that the measurements of the Great Pyramid prove that the Egyptians measured the earth to get their standards and that the Babylonian 'cubit' was derived scientifically in some similar way, but this is mere speculation.

French scientists took up the idea of the Lyons vicar with much interest, and as there were over 200 different units in use in France at that time it was a much-needed reform, but it was a hundred and twenty-five years before it became law there for all purposes, in 1795. Many people think that it was the French Republicans after the Revolution to whom the credit for authorising the metric system belongs, but its introduction had been sanctioned by King Louis XVI: the Revolutionaries merely brought the work to a conclusion and made it law. For a great deal of hard and careful work was needed to make the new unit of length, which was to be one ten-millionth of the distance from the earth's Equator to the North Pole. What was actually measured was the distance from Dunkirk in France to Barcelona in Spain, which was rather more than one-tenth of the distance from the North Pole to the Equator, about 660 miles. Both these

places are at sea-level, but there were the Pyrénées and other mountains in between, which had to be allowed for by complicated calculations. It took the engineers seven years to do the necessary work, and then from the results the length of the metre was calculated and a standard metre made.

The smaller units were given Latin prefixes (deci, centi, and milli) but the names given to the larger ones were most unpopular, for the Greek prefixes deka, hecto, kilo, though they meant 10, 100, and 1,000 just the same as the Latin, were unfamiliar and much harder to remember, as we find them still. The metre being about 39·37 inches was suitable for measuring material and buildings, while the kilometre (about five-eighths of a mile) was useful for distances such as we should measure in miles or furlongs.

Our pound-weight has no connection with the yard, but the French decided to make their new unit of weight, and all the others too, depend on the metre so that all of them depended, ultimately, on the size of the earth. Area and volume were easy; squares and cubes with their edges a metre long, or any other metric length, were obvious. Special names were given to the square deka-metre and the cubic metre, 'are' and 'stere', and multiples of these such as the hectare or dekastere could then be used. The gram-weight was defined as the weight of a cubic centimetre of water at a temperature of 4° Centigrade. This was too small for general use, so a platinum weight was made 1,000 times as heavy which became the chief one, the kilogram-weight, rather more than two pounds-weight. For capacity, a cubic metre was too large for buying milk and other liquids, so a cubic decimetre was taken as the standard and given a new

name, the litre. It is about one and three-quarters of our pint.

The metric system was therefore a much more orderly and scientific system than any that has grown up during centuries like ours, and gradually all European countries followed suit and changed their money and weights and measures to systems based on tens and hundreds. The United States of America have a decimal coinage, but have kept the weights and measures which their forefathers took from this country. Fifty-four countries have agreed to base their systems on the International Metre, a platinum bar kept at Sèvres which now has a treasure of a more solid nature than the china for which it is famous. The standard kilogram-weight was in 1927 defined as the weight of a certain platinum cylinder, and the standard litre derived from this; so that now, like ours, the metric units of length and weight are independent.

The first Englishman to suggest the decimalisation of English weights and measures was the inventor of the steam engine, James Watt, who was so annoyed at the trouble it took him to compare some experiments by a French scientist with similar ones made by an Englishman that he proposed a new scheme with ten ounces in a pound and so on.

But the hatred of the French caused by the wars against Napoleon hindered the introduction of the metric system into this country and up to 1897 anyone using it in trade could have been fined five pounds. In that year a law was passed giving permission to everyone to use metric weights and measures in England for any purpose. The Committee of 1960, referred to on page 54, did not recommend compulsory adoption, but said watch should be kept on the world situation: the U.S.A. and

some parts of the Commonwealth still use our system of weights and measures, though they have decimal coinage. The Committee recommended improvements in our system by the substitution of the 'central' and 'short ton' for our cwt. and ton; the deletion of less-used units, e.g. rod and bushel; and more use of decimals of units instead of fractions. Gradually the metric system is coming more into our everyday lives; you and your luggage are weighed in kilograms before you take your seat in the airliner; the Ordnance Survey one-inch maps have a grid dividing the area into kilometre squares; and even cotton reels frequently have printed on them the weight of cotton in grams instead of the length on the reel in yards. Public opinion in business circles has also grown stronger in favour of the change. Business men say that they would be saved expense, for offices need more clerks to deal with the bookkeeping, etc., for transactions in different kinds of weight or money. In foreign trade, catalogues must often be sent instead of samples, and a customer who has to choose between an article for which the measurements, or various sizes in which it is stocked, are given in unfamiliar units and another where these are familiar will choose the latter, for there is less likelihood of his ordering a wrong size and having the trouble and delay of returning it and getting the right one. For spare parts of machinery there must be exact uniformity of size and this means that a machine where the parts are made to a metric standard may be preferred by a foreign purchaser to one made by our measurements, because he might have to send to England to replace worn or lost parts. Even with little things like screws endless trouble has been caused because some screws were made with so many threads to an inch, others so many to a centi-

metre; the old 'snowball' rhyme about the kingdom that was lost 'all for the lack of a horseshoe nail' could be brought up to date by turning the rider of the horse into a factory hand, engaged on vital work, rendered idle while a screw identical with one that had worked loose in his machine was being found. November, 1948, saw the end of thirty years of negotiation in the signing of an agreement for standardising nuts, bolts, and screws between Britain, the United States, and Canada, which the *Daily Telegraph* called 'one of the most important steps towards practical co-operation among the nations' and which it was estimated would save each country vast sums every year.

The practical objection against the change to the metric system is the cost and inconvenience of replacing existing machinery such as steam engines, looms, and all their etceteras, and all the weighing and measuring apparatus in shops and elsewhere. The butchers' and grocers' weighing dials, the automatic yard-measurers on the drapery counter, the petrol pumps at the garages, would all have to be scrapped or modified. The cost to individuals might be ruinous; while if the change were to be paid for by the State, the burden of taxation would have to be increased.

In addition, ordinary folk would find it very confusing at first, especially the older ones. The French Government found that the people firmly refused to give up their familiar terms, and, finding it impossible to punish all those who broke the law, passed another allowing the old names to be used for some years, and the half-kilogram is still unofficially known as the *livre*, which was the old pound, and somewhere about the same as the half-kilogram. In Germany, too, the abbreviation

lb. can still be seen in shop windows and the word 'Pfund' (pound) heard on shoppers' lips. If we had the metric system here, we should probably call one-third of a metre a 'foot'—it would be about $13\frac{1}{3}$ inches—and half a litre a 'pint', though the milkman would have to have an entirely new supply of bottles, and we should get less milk in the new pint than the old.

The French Revolutionaries decided to 'go the whole hog' and along with the weights and measures decreed that time must be divided decimally thus:—

$$100 \text{ seconds} = 1 \text{ minute}$$

$$100 \text{ minutes} = 1 \text{ hour}$$

$$10 \text{ hours} = 1 \text{ day}$$

But apart from ease in reckoning a day's wages from an hour's, there was no practical advantage in this innovation to set against all the existing clocks being useless, and the French people stuck firmly to the twelve-hour day, which was restored officially by Napoleon.

The Revolutionaries also abolished the division of a circle into 360 degrees, which has its origin as far back as the ancient Chaldean astrologers, and instead divided the right angle into 100 degrees, and so the circle into 400. This, too, met with disapproval and ridicule. Germany passed a similar decree in 1938 and ordered the new geometry to be taught in schools forthwith, though sailors were to be allowed some years to get used to the change before its use became obligatory; mistakes in school children's sums not having the disastrous results of an error in navigation.

Further knowledge of the earth's surface has shown that the distances from the North Pole to different points on the Equator are not exactly the same, so that metres

calculated from measurements made in different countries would not agree. That is why so many nations have agreed to use the International Metre at Sèvres, that is, they define the metre, just as our yard is defined, as the length of a particular bar of metal.

But it is possible that this bar might be destroyed, and all reliable copies of it. Though this is unlikely, there ought to be some means of making another standard in case of a world-wide catastrophe, and scientists looked round to see what would be the best.

One thing which suggested itself as constant was the length of the pendulum which takes a certain length of time for its swing to and fro, say, one second. That a pendulum of a certain length, set swinging, takes the same time for each successive swing regardless of how far it goes from side to side was discovered by the famous Galileo, who invented a pulse-taking apparatus on this principle after he had used his own pulse to test its truth while watching a swinging lamp in a church one day at Pisa. The length of the pendulum that swings from side to side in one second is about 39 inches, not much less than the metre, but more accurate experiment has proved that Galileo's discovery is only partially true, and that the same pendulum set swinging in different places would take slightly different times and that in course of years the time varies even at the same place. So as an international and permanent measuring rod the pendulum will not do for the standard of accuracy demanded in the twentieth century. Something in nature even more constant was sought, and this was found in the length of the waves of light. Most people know that light travels in waves, the distance between the crests of successive waves being less for blue than for red light. The distance

from crest to crest for each colour has been found and expressed as a decimal of a metre, a decimal beginning with six noughts, it is true, but it is only a matter of inversion to calculate from this the length of the metre in terms of any of these wave-lengths. In 1927 an international conference decided that if the standard metre were destroyed, it should be reconstructed by making it 1553164.13 times the length of the waves of red light radiated by cadmium vapour under certain conditions. If we ever reach the stage of intercourse with inhabitants of other planets, if such exist, this method could also provide an inter-planetary standard of length because, while swinging pendulums and measurements of surface would vary from planet to planet, the natural elements found on the earth are distributed throughout the universe.

This development of the standard units shows how the standard of accuracy has been improved during the course of the centuries. From the days when a man would measure with his thumb, to 1851 when Sir Thomas Whitworth invented a measuring machine capable of detecting differences of one-millionth of an inch—which is about $\frac{1}{1000000}$ of the thickness of a human hair—mankind has travelled a very long way.

Not only has man improved and made exact the old units, but he has had to invent new ones—far smaller and far larger. To record his work with waves such as those in which light travels and his researches on the sizes of atoms, he has given a name to the millionth part of a metre—the ‘micron’, and even to the thousandth and ten-thousandth parts of the micron; and to plumb the depths of space and describe the distances of stars and nebulae, even the megameter (a million metres) is

inadequate and astronomers have evolved a far larger unit—the 'light-year'—not a period of time but the distance a ray of light can travel if it speeds through space for a year.

Modern life requires the measurement of many other properties of matter than length and weight, and the use of many tables besides those given in the tables of weights and measures we learn as children. For weather forecasts the height of the barometer, the dampness of the air, the force of winds, the temperature, all need measuring and must each be measured with units of different kinds. In our houses our consumption of electricity and gas has to be measured before we can pay for it, and when we buy a car we enquire its horsepower and the number of miles it can do to the gallon.

The things measured at the National Physical Laboratory include doses of X-rays, the amount of noise that goes through walls of different materials used in building flats, the strength of concrete floors, and the insulating capacity of substances used in making refrigerators. They have a wind-tunnel to measure the effects of streamlining on the speed of aeroplanes, and a water tank for tests with models on the results of modifying the shape of the hull or the type of propeller of ships and seaplanes.

The measuring of gas shows how measuring keeps pace with human needs. Gas was first used for street and then for house lighting and the quantity used was measured in cubic feet. But the quality also needed measuring, for poor gas gives little light, so a certain standard of illuminating power was created, to which the gasworks supplying it were expected to conform. The illuminating power of any kind of light is expressed by

saying that it is so many candle-power, i.e., it gives as much light as a certain number of candles, which of course must be standard candles. But these are not easy to make, so the National Physical Laboratory keeps a set of standard lamps, each of which is supposed to give as much light as some number of standard candles.

But as electricity supplanted gas for lighting and gas fires came into use, the lighting power of gas became much less important than its heating power and since 1920 we have been charged for the amount of heat we get, for 'Mr. Therm who burns to serve you' is a unit of heat. The dials on our gas meters are still labelled in cubic feet, but the gas must be of such a heating quality that these can be converted into therms.

Electricity has made necessary the invention of a whole new series of measuring units, the watt, the ampere, the volt, and the ohm, with their metric multiples and smaller parts, and even the most unscientific of us needs to use these words sometimes; when we move, for instance, into a new district and find the electrical gadgets we have transported with us must be adapted to a different voltage, or are told that the wiring in the new house will not permit the use of our two-kilowatt fire. To the next generation these terms may be as familiar as the foot and pound were to their forefathers.

For it is clear that the measures in use are those required by the individuals that form the community, for the purposes of exact description and comparison, to enable trade to be carried on conveniently and honestly and to further the growth of our knowledge of the universe we live in. And new needs and new discoveries must be accompanied by new ways of measuring them, or progress is impossible.

CHRONOLOGY

A.D. 958-975	King Edgar.	Earliest recorded attempt to institute standard measures.
Uncertain date	Henry III or Edward I.	Assize of Bread and Ale.
Uncertain date	Henry III or Edward I.	Statute about Bakers.
Uncertain date	Edward I.	Assize of Weights and Measures.
Uncertain date	Edward I.	Statute for Measuring Land.
1297	Edward I.	Reaffirmation of Magna Carta—the standards to be made more uniform.
1495	Henry VII.	New standards constructed—the earliest still in existence.
1588	Elizabeth I.	Better standards constructed.
1670		Metric system first suggested.
1795		Metric system adopted in France.
1824	George IV.	Weights and Measures Act.
1834	William IV.	Fire destroys standards.
1855	Victoria.	New 'Imperial' standards legalised.
1878	Victoria.	Weights and Measures Act.
1897	Victoria.	Metric system made legal for use in England.

PART III
MEASURES OF TIME

Chapter I

NATURAL AND HUMAN DIVISIONS OF TIME

WHY is it important to have a good calendar? Why did Turkey discard the Muhammadan calendar along with the fez and the veil in 1927? Why did Russia 'sovietise' the Polish calendar within a few days of her entry into Poland in 1939? Why did the League of Nations think calendar reform of sufficient importance for a committee to work hard for three years on it?

The need for measuring short periods of time is obvious; without a clock we could not be punctual for meals and appointments, or catch our trains. But even in uncivilised communities men need to measure longer periods; the hunter must know when certain animals come out of their winter sleep, and if the farmer does not plough or sow his corn at the right time, his labour will be wasted. As soon as a community reaches the stage of civilisation where wages are received and rent paid, the times when payments are due must be determined accurately, or there will be confusion and ill-will. To businesses and banking a calendar is indispensable; the word itself, which we get from the Latin 'calendarium'—an account book, or ledger for entering interest—shows that even in Roman days this was so.

If a nation is to have any history, great events of the past must be shown in their proper order and relation to one another, and historians would have been saved many headaches if the calendars of ancient nations had been less imperfect. And not only the past but the future

needs dating; astronomers must publish information about the stars for the use of shipping; all trade involves promises to pay or deliver at future dates, and nations undertake non-aggression pacts and make trade treaties for a specified number of years.

Moreover, a good calendar is essential for anniversaries and religious observances. In primitive religions, not to appease the gods by the rites due at such times as harvest or the return of spring would be thought to endanger the welfare of the whole community, and a repetition at the proper time in mime or masque of the stories of how men got blessings from the gods is expected by magic to ensure the continuation of these blessings and keep mankind in harmony with the heavenly beings. In his play *The Clouds*, the Greek Aristophanes voices this idea when he makes the Moon appear and complain bitterly of the inaccuracy of the Greek calendar; she says, 'When you ought to be sacrificing, you are racking witnesses, and often when we gods are keeping a fast, you are pouring out libations and laughing'. In any religion, people like to remember the chief events of its founder's life at the appropriate season, and when calendars disagree about that season, feelings run high. As recently as 1935 several lives were lost in a riot in Roumania which arose because a priest had celebrated a certain festival according to a calendar that was not the legal one, but which his conscience commanded him to use.

As a result of this close and universal relation between time and religion, we find that calendars of most early nations were made by their priests, and the way of regulating them often kept as a sacred mystery, and sometimes declared to be a result of divine revelation.

But apart from this, the priests were the learned class and had more leisure to study the heavens than other people and to keep records of events there on which a calendar could be based.

For the heavens supply us with natural divisions of time. As the writer of Genesis put it in the Creation story—‘And God said, “Let there be lights in the firmament of the heaven to divide the day from the night; and let them be for signs, and for seasons, and for days and years”.’

The Day

The recurrence of light and darkness, day and night, is used by all races all over the world to measure the passage of time. It seems curious to us that primitive people often reckon the number of nights that pass rather than the days, and where we should speak of so many ‘days’ journey, will speak of so many ‘darks’ or ‘sleeps’. We still retain a relic of the same idea in the word fortnight, i.e., fourteen nights, and an old name for a week is a ‘sennight’.

But the word ‘day’ is very ambiguous; its simplest meaning is ‘daylight’—sunrise to sunset. But this varies in length from day to day except at the Equator, and the length of a ‘day’ in Arctic regions where in summer the sun never sets would then be several months. Gradually another meaning became common—day and night together, the period of the earth’s rotation on its axis, which is one of the most constant things in nature. For though there is some evidence that it is lengthening, it is only at the rate of perhaps a second in ten thousand years, which is far too small to affect its value as the fundamental time measurer.

The Month

The moon provides the next natural period, and a very useful one, in her time of revolution round the earth, from one new moon to the next. The word 'moon' is derived from a Sanskrit word meaning a measurer. In early civilisations the day on which a new month of the calendar was to begin and the number of days that a month was to contain were matters of local announcement in a public place, after it had been decided by observation of the moon herself. Only a hundred years ago a writer on the calendar could say of Muhammadan lands 'a new month begins when two trustworthy Moslems have observed the crescent moon in open field or on mountains and notify this to the authorities',¹ and this sort of thing must have taken place in the ancient civilisations of the world until the royal astrologers learnt, from observing the time of full moon, that they could announce to the king when the next new moon would be due, which fact was then publicly announced to the people. Many primitive races held feasts at new or full moon so that these announcements were also notices of the public holidays.

In Egypt and Assyria the month seems to have been reckoned at first as lasting thirty days, as in Genesis where the waters of the Flood are said to have 'prevailed upon the earth 150 days', and to have begun in the second month on the seventeenth day, and the Ark to have rested on Ararat in the seventh month on the seventeenth day. Closer observation led people to the better value of $29\frac{1}{2}$ days (the *average* value at present is 29.5305879 days, though individual months vary from

¹ J. Hastings. *Encyclopædia of Religious Ethics*, Edinburgh, 1909, et seq. Article on the Muslim calendar, vol. III, p. 127, quoting from C. L. Ideler, *Handbuch der Chronologie*, 1825-6.

29 days 7 hrs. 20 min. to 29 days 19 hrs. 30 min.). From this calendars with months of 29 and 30 days alternately were devised.

The Year

The third great division of time is suggested by the recurrence of the flowering of plants and the ripening of fruit, wet seasons, or strong winds, and the various



Fig. 7.—Reckoning the years by notches in ancient Egypt. One god fashions a man on a potter's wheel, while another marks the years of his life on a notched stick.

occupations that take place as a result of these changes in weather. If you ask an Eskimo when something happened, he may answer 'when eggs are collected' or 'when seals are caught'. This sort of thing may form a primitive calendar such as that used by the Dyaks of Borneo, who divide the year into eight periods known as the time for clearing brushwood, time for felling trees, time for weeding, and so on. These look as if they might almost take the place of our months, but there is this

big difference, these 'seasons' are often vague and no one knows exactly how many days they last, and some may last much longer than others.

Moreover, a number of seasons as large as this is unusual. The Jews had six in ancient times, the Egyptians three (inundation by the Nile, sowing season, growing season). The Anglo-Saxons, like most Celts, merely divided the year into two halves, 'Summer', by derivation, means half a year, while 'Winter' is probably akin to 'water' and 'wet', and is therefore the wet season.

The languages of all Aryan races, however, have words that come from common roots for *three* seasons, our summer, winter, and spring (the season of springing or growth). Our fourth season, autumn (the word is connected with the Latin 'augere' to increase, referring to the harvest), is a later innovation and to make room for it the length of the other three was reduced.

In tropical countries, the rainy seasons and high winds are much more regular and marked than with us, but still such events as the coming of the geese or the flowering of the peach trees may vary by two or three weeks from year to year. There are, however, some events of another kind much more sure; from the earliest times men have noticed how some constellations (such as Orion, the Pleiades, or Sirius) suddenly appear one evening in the western sky at twilight, and are higher and higher in the sky each night at the same time until they are in the east at twilight, after which for a while they are seen no more. The Bedouins of Arabia still time their annual round of wanderings by the stars; when Canopus can be seen, they leave the borders of the cultivated districts and go off into the desert, and when

Arcturus can no longer be seen they return. Often the stars, or the god they represented, were considered the cause of earthly events which took place at the season of their coming; the Egyptians thought Sirius caused the annual Nile flood because that happened at the time of year when the star made its appearance on the horizon just at sunrise, and some natives of New South Wales argued with an explorer that warmth came from the Pleiades and not from the Sun 'because the sun is in the sky all the year round, while the Pleiades only appear during the summer'.

Other primitive peoples noticed that the sun, as seen from their camp or village, rose behind different hills, or clumps of trees, at different times of the year, the change being in one direction from the shortest to the longest day and then back again. They used this to make a rough calendar, watching sunrise until certain landmarks gave sowing time or a warning to get in the harvest before the rains came.

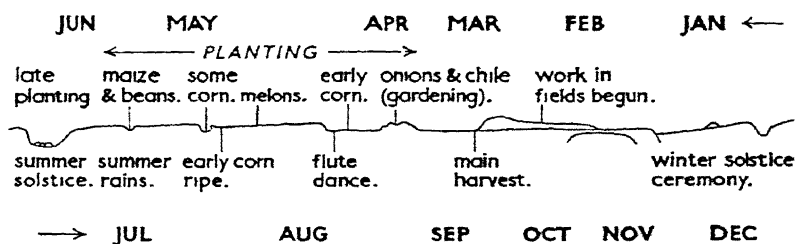


Fig. 8.—An Indian Horizon Calendar (from a native drawing).

Some peoples also took note of the variation in the length of the days and in the position of the sun in the sky at midday, both of which are much harder to observe accurately than a heavenly body on the horizon, but in

one way or another the approximate value of 360 days for the length of the year was arrived at by most ancient civilisations. 'Twelve are the months of the year, six sixties are the days of the measure of the year's beginning', runs an ancient Assyrian inscription. To the Egyptians and the Chinese must be given the credit for the earliest use of the better value of 365, while the Egyptians were also, later, the first to use the further refinement $365\frac{1}{4}$.

The Hour

What has man found it convenient to add to nature's divisions of time? First of all he split up the day into convenient parts, perhaps at first just into the morning, the middle of the day, and the evening, and then into more and shorter periods. Muhammadans still divide the day by their five periods of prayer. The Romans divided the night into four watches; our navy still uses the same word for the periods of duty throughout the twenty-four hours, and from this the watches we wear got their name. But the origin of the custom of dividing the day and night each into twelve parts is lost in antiquity, and was used both in ancient Egypt and Mesopotamia. Perhaps it was suggested by the twelve months in the year. But the 'day' was the old day of sunrise to sunset, and as the days lengthened or shortened so did the hours of the day, because each was one-twelfth of the day, whatever length that happened to be, while the hours of the night were each correspondingly short in summer and long in winter. Not till clocks replaced sundials did the idea of having all the twenty-four hours equal prevail, and our phrase 'ten o'clock', i.e., of or by the clock, has its origin in the days when both systems

were in use and it was necessary to make clear which one you were using.

The division of each hour into minutes and seconds is a further stage in accuracy in time-telling, and the number of seconds in a minute and minutes in an hour is a legacy from the men of Babylonia. In their arithmetic, the number sixty was very important, quantities being grouped in sixties and fractions expressed with sixty as denominator. Perhaps its popularity arose from it being one-sixth of the number of days in the year, when that was taken as 360. That suggested the division of the circle into 360 degrees, so that one part corresponded to the daily apparent movement of the sun among the stars, and the circle divided into six gives us the familiar six-sided polygon or six-pointed star with angles of sixty degrees at every corner, both of which have been used in design or ornament from very early days. This popularity of the number sixty caused it to be chosen when, about the time that hours of equal length came into use, the hour was divided into minutes and seconds, not earlier than the thirteenth century. The names, of course, that we use are Latin, minutes are small or *minute* divisions of time and seconds the *second* dividing of the hour.

The Week

If we want to divide the lunar month, the two halves of waxing and waning suggest themselves at once. The Celtic people even counted the days 1-15 and then 1-15 or 1-14 over again (according as the moon lasted thirty or twenty-nine days). The Roman method of dating days by the Ides and Kalends is another case, for they are just the days of new and full moon. We talk of the

four 'quarters' of the moon, but they are much harder to see accurately than the two halves, and as ten is used universally for counting, it is more common for people to divide a month into three periods of ten days (growing moon, time of full moon, waning moon) than into four quarters. When, at the French Revolution, the metric system was introduced and the calendar reformed, ten-day weeks were decreed, but they were very unpopular. Soviet Russia now has a five-day week, which is half as long, and from the sagas of the ancient Norsemen it is clear that their month consisted of six weeks each of five days.

For many nations the idea of a recurrent rest day has not developed from the moon at all, but from the market. Markets every fourth day are very common all over Central Africa, and markets at intervals of all numbers of days from three to ten are known in other parts of the world. The Romans had an eight-day week, each eighth day being a market and a school holiday and feast. Market day naturally becomes a rest day because people go to market instead of working, and becomes a feast day because they meet together there.

The popularity of the seven-day week may be due to its being almost a quarter of the month, or to the sacred cult of the mysterious number 7. We possess ancient calendars from Assyria in which every seventh day is marked as an evil and unlucky one, on which no work should be undertaken; and the Jews probably got their Sabbath from this. From the East the observance of a seventh day of rest spread to Rome about the time of the birth of Christ. Whether it came to Britain before Christianity or was introduced by Christian missionaries is uncertain.

Chapter II

MAKING A CALENDAR

THE sky, as we have seen, provides us with the day, the lunar month, and the year. If only the moon would rotate round the earth in an exact number of days or if the earth went round the sun in an exact number of lunar months, calendar making would be easy. But neither moon nor earth is so obliging! The moon goes through its phases not twelve times in a year, but 12·3682668 times (to quote the *Nautical Almanac*). So calendar-inventors have to choose one of three possibilities:—

(1) A purely lunar calendar, following the moon and neglecting the solar year. Each month will begin with a new moon, and twelve of them will take up about 354 ($12 \times 29\frac{1}{2}$) days instead of 365, so that next year all dates by the calendar will be eleven days further back among the seasons than they are this year, and eleven more days each year until they have travelled all round the seasons.

(2) A purely solar calendar, in which the name month is given to the time taken by the earth to do one-twelfth of her revolution round the sun, the time for the sun (apparently) to travel through one of the twelve signs of the Zodiac; or the month can merely be a name for any convenient number of days without any connection with the moon.

(3) Or lastly, a calendar with months following the moon more or less, but kept in good agreement with the sun by putting extra days in the calendar every now and then.

The chief instance of the first kind of calendar is that in use in Muhammadan countries, instituted by Muhammad himself. This exalts the moon to a place of honour in the calendar as in their flag with the crescent moon on it. Each month begins in an evening within twelve hours of the exact time of new moon, and each contains either twenty-nine or thirty days, and New Year's Day (and every other day) changes its position in the seasons from year to year, going right round the seasons in a period of thirty years.

Such a calendar is no help at all to farmers as a guide as to when to plough or sow, and its difficulties must have been very apparent to some Lascar sailors (Muhammadans) one year when their month of Ramadan happened to begin in our June. Ramadan is a 'fast' month, during which Muhammadans eat no food during the day, but only after sunset; these sailors found themselves at this time within the Arctic Circle—and the sun never set at all!

As an example of the second kind we may take one of the most interesting calendars of antiquity, that of the Mayas of Central America. The Mayas counted in twenties instead of tens, as most people do, and they discarded the moon's period and used instead months of twenty days, eighteen of which made a year, together with five extra days, which they considered of the greatest ill-luck. No one washed or combed his hair or travelled on these days, and a baby born on one of these days was thought to be doomed to misfortune all its life. The Maya method of recording dates is also remarkable, for as well as giving the day of the month, it also gave the position of the day in another sort of 'year' of 260 days (13×20) and made treble sure by adding the number of






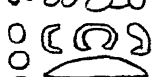

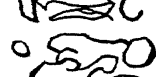
	Head of a God.		
	I Great Great Great Bactun	containing 3,200,000 years or 1,152,000,000 days	
	11 Great Great Bactuns	each containing 160,000 years or 633,600,000 days	
	19 Great Bactuns	each containing 8,000 years or 54,720,000 days	
	9 Bactuns	each containing 400 years or 1,296,000 days	
	3 Katuns	each containing 20 years or 21,600 days	
	6 Tuns or years of	360 days or 2,160 days	
	2 Uinals or months of	20 days or 40 days	
		Total	1,841,639,800 days or over 5,000,000 years.

Fig. 9.—A Maya calendar date. Numbers can be seen at the left of each hieroglyph; each o is 1 and each 0 is 5.

days which had elapsed since the creation of the world (which according to Maya ideas occurred in 3373 B.C.). It is perhaps as well for those of us who are weak at calculations that when the Spaniards conquered them in Elizabethan times they were not filled with such admiration at this mathematical marvel as to desire to introduce it to Europe; on the contrary they decided that it was so different from their own Christian calendar that it could only be the invention of the devil.

The great majority of the human race have tried to make the best of both sun and moon, by using a calendar of the third kind, by what is known as 'intercalation', literally 'calling out'. This word goes back to days when from observation that the agricultural seasons or the appearance of the constellations in the sky were not in agreement with the calendar, a public announcement of an extra period to be put in the calendar was 'called out' in some public place so as to bring these events into their right place.

A very common method was to 'call out' a thirteenth month in the year. A notice sent out by the Chief Rabbi to the inhabitants of Judæa and Galilee about A.D. 100 has been preserved and runs: 'We make known to you that the lambs are small and the young of the birds are tender, and the time of the corn-harvest has not yet come, so that it seems right to me and my brothers to add to this year thirty days'.

Another method was in use in Iceland from about A.D. 960, when it was decreed that every seventh summer should be increased by a week; while a third method is to insert single days, which will be done more frequently, of course, and will keep the calendar in better accord with the heavens.

Let us now look at some of the calendars from which our own is derived.

To the Egyptians, anxiously awaiting each year the new life given to the parched land when the river rose, the calendar was of vital interest. As has been said, they can claim the earliest use of 365 days and later of $365\frac{1}{4}$ days as the length of the year, and they were the earliest nation to have a calendar fixed according to a definite rule of calculation.

They had twelve months of thirty days with five extra days put in at the beginning of the year. These were dedicated to the five chief gods and not counted as part of any month. This calendar is still used in Ethiopia. But a year of 365 days has the serious disadvantage that the error of a quarter-day shifts the calendar back one day every four years—only two or three weeks in a man's span of life—so that to individual observation the discrepancy might be easily put down to variations in weather and in the forwardness of crops from year to year; but in the course of centuries, the shifting would be clear. We have references to this in inscriptions; 'an unfortunate Egyptian official despatched to the mines of Sinai arrived there in the third month of winter, when he and his men suffered greatly from the summer heat' and so on. In 238 B.C. Ptolemy III Energetes passed a decree to rectify this, inserting an extra day in the calendar every fourth year, and this is the birth of the idea of leap year. The Egyptians, however, were too attached to, or too proud of, their old calendar in spite of its faults to accept the reform. Certainly its age was a matter for pride; and some Egyptologists have gone so far as to declare that they could date its invention positively to the year 4241 B.C. This would be the very earliest date in recorded history, but even if this figure is wrong, the Egyptian calendar was a marvellous achievement for an early civilisation and far superior to many much later ones.

The origin of the Babylonian calendar is likewise lost in antiquity. From them we have got the idea of the seven-day week, twenty-four hours in the day, and the sixty minutes and seconds. One of their astronomers, Naburianos, about 500 B.C., gave a value for the length of the year equivalent to 365·2609 days, which was much

more accurate than any value used by the Egyptians or any other race. Their months were lunar ones, and extra months were put in to keep them in their right relation to the year. In early days this happened whenever the astronomers reported to the king that it was needed, but later they attempted to do it according to a plan or cycle, in which extra months were put in at certain definite intervals distributed throughout a number of years.

The Greeks developed this idea of inserting months according to a plan. They used an eight-year cycle during which three extra months were inserted, and half of this period, four years, was the length of time between the holding of successive Olympic Games and may have suggested our leap-year arrangement every four years. Later, a very accurate arrangement by which seven extra months were inserted in every nineteen years was suggested by the astronomer Meton, and this cycle, known as Meton's cycle, is still of importance in fixing our movable religious festivals.

Chapter III

THE ROMAN CALENDAR AND ITS DEVELOPMENTS

It is to the Romans that we owe most of all in calendar matters. There was an ancient tradition that their year originally had ten months and that Numa Pompilius (716–673 B.C.) added January and February to the rest, but the earliest calendar of which we can be sure ran as follows:—

March . . 31 days	September 29 days
April . . 29 „	October . 31 „
May . . 31 „	November 29 „
June . . 29 „	December 29 „
Quintilis . 31 „	January . 29 „
Sextilis . 29 „	February . 28 „

This gives a total of 355 days, which is practically twelve lunar months ($12 \times 29\frac{1}{2} = 354$) and shows that originally the calendar was meant to keep pace with the moon. But the Romans disliked even numbers and considered them unlucky, and to avoid having months with an even number of days, they forsook the moon and gave the months either twenty-nine or thirty-one days (instead of either twenty-nine or thirty) except February, which was dedicated to the gods of the lower world and the dead, so they did not mind if it had an unlucky number of days in it. To make the calendar keep pace with the sun, an extra month of twenty-two or twenty-three days was supposed to be inserted in every other year, and the duty of seeing that this was enforced was given to the pontiffs

(officials discharging the duties of priests). Unfortunately they misused their powers, and instead of adding the extra days when they were due, added them when it would extend their own or their friends' times in office, and omitted them to shorten their enemies' periods of power, with disastrous results to the calendar.

By Julius Cæsar's time the winter months were falling in the autumn so that the harvest was being reaped when, by the calendar, winter storms should have been raging, and a reform was urgent.

Julius Cæsar called in as adviser Sosigenes, an astronomer of Alexandria in Egypt, the country which had been the pioneer of good calendar-making. The year 46 B.C. was made to last 445 days to put the seasons right, and then the new calendar was brought into force. This made the year 365 days long, instead of 355, by adding one day to some months and two to others, and January was made the first month of the year (because it had for some time been the custom for the annual officials in Rome to change office at that time), so that the months now ran, as they do with us:—

January . 31 days	Quintilis 31 days
February 28 „	Sextilis . 31 „
March . 31 „	September 30 „
April . . 30 „	October . 31 „
May . . 31 „	November 30 „
June . . 30 „	December 31 „

This made months which agreed very little with the movements of the moon, but it was felt that that was less important than agreeing with the sun. Four of the months now had an even number of days, as the superstition against these had rather faded by this time, and February was left with twenty-eight so as not to disturb

the religious festivals in that month, though, as it was no longer the end of the year, it made the very odd arrangement of the days in the various months even odder. Why this very unsymmetrical plan was adopted no one knows, but in the thirteenth century a story was invented to account for it. This said that the plan was not due to Julius Cæsar, but that he made the months have alternately thirty-one days and thirty days (except February, which had twenty-nine). Quintilis was renamed Julius in his honour in 44 B.C. In 8 B.C. it was decided to rechristen Sextilis after his successor Augustus, and the story said that, not to be outdone by his uncle, Augustus made his own month have thirty-one days like July, and then, to prevent three months of thirty-one days coming together, interchanged all the remaining months, which gives the months their present form. But as calendars of earlier date than 8 B.C. have been discovered with thirty-one days in Sextilis, Julius Cæsar cannot be cleared of the responsibility for causing us all to have to burden our memories with the well-known rhyme; before it was made (about 1590) the burden must have been greater still.

But this defect must be put against the great improvement in the Julian calendar over all preceding ones, in the institution of leap year. Sosigenes evidently copied the idea from the Egyptian attempt 200 years earlier. The Romans thought of it not as an added day, but a double day, that is, the day before was counted twice as long as usual; if the day before was a Monday, the extra day was still Monday and the day *after that* would be Tuesday, and this idea lasted for centuries. Henry III in 1236 made it English law that 'the day of the leap year and the day before should be holden for (i.e., held to be) one day', so a person born on February 29th is legally justified in

keeping his birthday on February 28th in other years. However, it was found more convenient for the day to be given a separate day-name, and the term leap year then arose, because, as we all realise, in these years anniversaries leap a day of the week, e.g., if a birthday fell on a Wednesday in 1963, in 1964 (after February) it would leap Thursday and fall on a Friday.

Although the Julian calendar was better than anything previous, it was not perfect. The leap-year plan of three years of 365 days and one of 366 days makes 1461 days in four years, or an average of $365\frac{1}{4}$. But the actual year was about eleven minutes short of $365\frac{1}{4}$ days, and eleven minutes a year mounts up to a day in about 130 years, so the error was soon noticed. It complicated the already difficult question of fixing the date of Easter, which was a cause of much strife and even of bloodshed in the early Christian Church. The Jewish Feast of the Passover was fixed thus—it was held on the fourteenth day after a new moon, and this new moon had to be the one whose fourteenth day came just after (or on) the spring equinox (the day of equal day and night), and as a new moon can fall on any day of the week, so can the Jewish Passover. Some Christians wanted to fix Easter by the Passover, on the eve of which the Last Supper took place, which meant that Easter Day might be also on any day of the week, while the majority wanted to keep it on a Sunday regardless of the day of the new moon. The Julian calendar made matters worse because, owing to the eleven minutes error, the spring equinox on which all the calculations depended kept slipping back in the calendar. When the calendar was instituted, it was on March 25th, but by the time the Council of Nicæa in A.D. 325 finally fixed the method of dating Easter, it

was on March 21st, and so it made the extraordinary-sounding rule for the date of Easter Sunday that we still follow—‘the first Sunday after the first full moon after the 21st of March’.

What calendar was in use in Britain in its earliest days we have no means of knowing. Stonehenge was certainly built to fix the longest day for a midsummer feast or ceremony. Perhaps the Druids had a calendar like the one dug up at Coligny near Lyons in France, which belonged to the Sequani, a Celtic tribe who lived there in the first century A.D. It has a row of holes opposite the dates, so that the owner could put a little peg in to mark the day and move it each day into the next hole. The months are either of twenty-nine or thirty days with an extra month of thirty days inserted every $2\frac{1}{2}$ years, in winter and summer alternately.

At any rate our original calendar must have been something similar to this one, for the earliest person to tell us anything about it, the Venerable Bede (A.D. 672–735): wrote: ‘The Angli in former times calculated their months according to the moon and intercalated an extra month in summer’.

But with advancing civilisation the Roman calendar came into use, and throughout the Middle Ages the Roman Church calendar with all its Saints’ days was in universal use.

But the annual error of eleven minutes went on accumulating and Easter became further and further from the spring equinox. The reform decreed by Pope Gregory XIII in 1582, and suggested to him by a Neapolitan called Aloysius Lilius, was the climax of a long effort on the part of the Roman Catholic Church to mend matters. Unfortunately, while Roman Catholic

countries at once followed the Pope's suggestion, the fact that the reform came from him was enough to arouse fierce opposition from the Protestants. The famous astronomer, Kepler, was refused communion because he (a Protestant) had advocated the reform. It was not till 1752 that prejudice allowed it to be made law in England. In that year eleven days were dropped out, much to the indignation and bewilderment of the ordinary people, and the artist Hogarth published a cartoon showing people clamouring 'Give us back our eleven days', by which they imagined their lives had been shortened. Certainly it was rather strange to be told that the day after September 2nd was to be called September 14th, but it put the calendar right once more. From then on, the 'Gregorian' calendar, as it is called, has been our legal one. This differs from the Julian one by not counting the century years, 1800, 1900, etc., as leap years, although they can be divided by four, unless they can also be divided by 400. Why does this help? We have seen how men learnt to replace 360 by 365 and then by $365\frac{1}{4}$; modern astronomy can give us a more exact value—the Nautical Almanac for 1964 gives 365.24219 days as the length of the year at present, or, in more familiar form, 365 days 5 hours 48 minutes 45.2 seconds, that is, almost $11\frac{1}{4}$ minutes short of $365\frac{1}{4}$ days. So the eleven minutes each year by which the Julian calendar was said to be in error on page 130 is more accurately $11\frac{1}{4}$ minutes. Now a calendar which loses $11\frac{1}{4}$ minutes a year on the sun loses $18\frac{3}{4}$ hours in a century, but if the last year of the century is not counted as a leap year, the calendar instead of being $18\frac{3}{4}$ hours behind will be $5\frac{1}{4}$ hours ahead. So the Gregorian calendar was in much closer agreement with the sun at the end of a century. But at the end of four

hundred years, the calendar will be twenty-one hours ahead, which is nearly a whole day. So it was decreed that the years 1600, 2000, etc., were to be counted as leap years. Then the calendar only loses three hours in every four hundred years.

To lose only three hours in four hundred years is pretty good timekeeping, but as the centuries pass even this small error will accumulate. The famous astronomer Sir John Herschel suggested that the year A.D. 4000 (when it comes!) should not be counted as a leap year, because by then the calendar will be almost a day behind. However, we can leave that to the people who will be alive then, especially as the time taken by the earth for its annual journey round the sun will have become slightly different by then from what it is now.

Chapter IV

MARKING THE PASSAGE OF TIME

The Beginning of the Day

OBVIOUSLY any measuring must have a starting-point—a place cannot just be ‘four miles’ but must be ‘four miles *from somewhere*’. So with time. We all know what may happen if we look up the 9.13 in the railway guide without noticing whether it is A.M. or P.M. But noon and midnight are not as simple to use as starting-points as sunrise and sunset. Modern Greeks and Persians still begin their day at sunrise, as the Romans used to do. Sunset is still the beginning of the day to the Jews, as it was when the Creation story was written—after telling what was made on the first day the Book of Genesis adds: ‘And there was evening and there was morning, the first day’ and the same for all the other days, that is, putting the night before the day. Muhammadans, Bohemians, and Italians do the same, and this is the reason for the Continental custom of celebrating a birthday on the evening before what we should consider the proper birthday. In some places, when striking clocks were first put in churches, they were set (and altered daily) so that 12 o’clock came at sunset instead of noon, so as to retain the old custom. For, of course, the times of sunset and sunrise vary from day to day, and to begin the day at noon, or its opposite, midnight, avoids this difficulty. Astronomers would prefer noon as the start of each day, so that all observations they made in the same night would bear the same date, but ordinary people would

find it very awkward if the morning's engagements were on one date and the afternoon's on another, so our civil day begins at midnight.

But we still use noon to divide the twenty-four hours into A.M. and P.M., a custom which arose about the time that the hours of the day were made equal instead of varying in length. Probably the use of the twenty-four-hour clock which the war made familiar to many people will render these terms obsolete in the future, and everyone will write 13.05 instead of 1.5 P.M. The idea of a twenty-four-hour clock is not new, but at least 150 years old.

There is an inconsistency, however, in our way of speaking of the hours; for while the seventh day, for instance, of the month is in progress, we say that the date is the 7th, and while the nineteen hundred and fiftieth year after Christ's birth is in course of passing, we call that year 1950, but if something happens during the seventh hour of the day, perhaps a quarter of the way through that hour, we say it happened at 6.15. To be consistent we should call it 7.15 (the fifteenth minute of the seventh hour). But we are all so familiar with the other that no one is misled.

The noon and midnight from which we measure the passage of the hours are no longer exactly sun times; the sun does not reach his highest position in the sky with sufficient regularity for any clock to follow him; in fact clocks only agree with the sun about the time of noon on four days in the year, and they differ by about a quarter of an hour in February and November. On top of this, when we are having 'summer-time' the clock and the sun are another hour or two hours apart, of course. Moreover, wherever we live in the British Isles, our noon

is the time that the sun reaches his zenith at Greenwich, and we used this even before Big Ben gave us Greenwich time with such accuracy. When people did not travel much, each town of any size decided its own time of noon, when the sun was at his highest at that place; but when railways came into existence, these variations made the making of timetables very difficult and railways took to using a standard time, and, as people travelled more, they found it necessary to explain frequently whether they were talking of 'railway time' or 'local time', which in Bristol, for instance, would be ten minutes behind the other. Think what it would be like if, when we heard the pips on the wireless, we had to set our watches, not by them, but a few minutes earlier or later according as to where we happened to be that day, or if when we travelled we had to alter our watches every few miles, and we can see what a good idea it was to have a standard noon for the whole country. The idea has been adopted by nearly all other countries, and most of their 'standard times' are based on Greenwich time, for a scheme was drawn up in 1884 by which the whole world was divided up into a number of 'zones' in which the official time of noon could be a certain number of hours or half-hours ahead of or behind Greenwich noon, arranged so that in each 'zone' the time of official noon agrees more or less with the time when the earth turns that part of her surface directly to the sun.

The Beginning of the Week

There is really nothing to mark out any one day of the week as the beginning more than another. The Muhammadan week begins on Friday, Slavs begin it on Monday, the Jewish Sabbath is on Saturday. The idea of Sunday

as the first day of the week comes from the Eastern worshippers of the Sun who gave him special worship on the day which bore his name. Christians took it over and turned the heathen custom to the service of their Lord just as they converted the heathen midwinter festival of Yule to Christmas and the festival of the coming of spring into Easter.

The Beginning of the Year

The heavens mark out specially four days in the year, the two equinoxes in March and September and the longest and shortest days. The equinoxes provide the easiest way to decide when a year has run its course, for the sun then rises due east and hence many ancient temples face east, or have long corridors set East and West to assist in the observation of the sun and decide when a new year begins. The longest (or shortest) day can be discovered from the shadow of a stick or obelisk by watching at noon to see when it is shortest (or longest). At Stonehenge a permanent means of identifying the longest day has been constructed, the stones being so arranged that the sun's rays fall on the centre stone at sunrise at the summer solstice.

But our year may have originally begun at the shortest day, for in Anglo-Saxon times and till Henry II's reign it began on Christmas Day, which is only three days later. Under the Plantagenets it became fashionable to start the year on March 25th instead. This was using Lady Day, the day of the Annunciation, instead of Christ's birthday, nine months later, and it also made the New Year not far from the spring equinox. Only when Gregory's reforms were adopted in 1752 did March 25th cease to be the official New Year's Day in England,

and January 1st take its place, as suggested by Julius Cæsar. To us it would seem very confusing not to have the beginning of the year at the beginning of a month, and the older custom has left one curious relic. Many thousands of citizens wrestling with their Income Tax forms must have wondered idly why they were asked to state their income for the year ending *April 5th*—but if we go back to the old New Year's Day of March 25th and add on the eleven days omitted in 1752, we see that the Inland Revenue Commissioners are still using the 'old style' New Year's Day, though under its 'new style' date.

Distinguishing the Days of the Week

The ancient Jews and early Christians merely numbered the days of the week as we do the days of the month. The Slavs and Lithuanians still do this, and so do Quakers in order not to have to use the names of heathen gods. But to give the days of the week the names of gods or of the seven planets is as old as the third century A.D. The idea of giving divine names to parts of the calendar arose in both Chaldea and Egypt. The stars seemed to form figures of men and beasts, and stories about these figures are nearly as old as mankind. One myth that we all know is the story of Perseus, and there are groups of stars which were given of old the names not only of Perseus and Andromeda, but of the monster, and the winged horse Pegasus on which Perseus rode, and Andromeda's sorrowing father and mother. Her mother's name was Cassiopeia, and the group of stars that, in a clearer atmosphere and to a vivid imagination, looked like a female figure, we nowadays generally recognise as a W.

In many of these myths, the gods were the heroes, and so gave their names to groups of stars or single ones,

and at the time of year when these stars were visible it was natural to do special reverence to the god, and to feel under his special protection, and to call that period by his name. From these beginnings there arose the whole system of astrology with its horoscopes and fortune-telling. To give each god a day for his special worship, and on which his protection might be invoked, was therefore very natural. In parts of West Africa where this is the custom, the natives also take their day of rest on different days accordingly: all the fishermen rest on the day dedicated to the god of fishing, and the farmers on another day and so on.

The Romans did not use names for the days of the week when the Julian calendar was made, but two or three hundred years later adopted the names of the seven heavenly bodies, the Sun, Moon, and the five planets they could see, Mars, Mercury, Jupiter or Jove, Venus, and Saturn. If they had known that three other planets, Neptune, Uranus, and Pluto, existed as well, we might be using a ten-day week now instead of one of seven.

Our northern ancestors used this idea, but substituted their own gods as far as possible. They dedicated the first two days to the Sun and Moon as the Romans did. Tiw, a god of battle like Mars, Woden or Odin, Thor, and Frigg, the wife of Woden, gave their names to the next four days. For Saturday no corresponding god existed, so some northern races took over the Roman name for the day, and so we get our present week. Other Scandinavian races used for the last day a name meaning bath-day, from which we may infer that the Saturday-night tub is an institution of very ancient origin. The use of these names must have been firmly established before Christianity came to these peoples,

so firmly indeed that the Christian missionaries, who would be certain to disapprove of this use of heathen gods, were unable to alter the practice. The Welsh used, and still use, the Roman gods instead of the Scandinavian, e.g., Wednesday in Welsh is *Mercher*, or Mercury's day, like the French '*Mercredi*'.

In medieval astrology, every hour had its presiding deity who influenced those born in that hour.

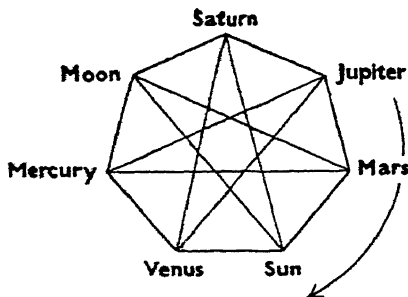


Fig. 10.—The diagram shows an old way of representing this rotation.

If the seven bodies are placed in the following order—Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon—and if, beginning with the first hour on Saturday, an hour is allotted to each in turn repeating over and over again

right through the week, it will be found that the first hour on Sunday belongs to the Sun, the first on Monday to the Moon, and so on.

Distinguishing the Months

The oldest names for months are 'nature' names, varieties of which are found all over the world. We still talk of the harvest moon and the hunter's moon though we do not call the months by these names. The Dutch names for the months are of this kind: chilly, vegetation, spring, grass, flower, summer, hay, harvest, autumn, wine, slaughter (of animals for winter food), winter.

The Anglo-Saxon names, as given by the Venerable

Bede in his writing on the calendar, include the dirty month (February), the rough month (March), the month of weeds (August), and the month for slaughtering (November). But when the Roman calendar came into use, these descriptive titles disappeared from the language, to our loss.

At the French Revolution the authorities rechristened the months with names of this type, e.g., Thermidor—the hot month—and a wag in England suggested that we should also revive them and proposed the following: Snowy, Flowy, Blowy, Showery, Flowery, Bowery, Beauty, Fruity, Shooty, Breezy, Sneezy, Freezy.

The Roman names are a curious mixture and the origin of some of them is uncertain. The most probable meanings are:—

January from Janus, the two-faced god who looked back on the old year and forward to the new one.

February from the Roman religious festival (Februa) held on February 15th. It was a day of purification and dedication, rather like our period of Lent which begins in this month.

March from Mars, the god of youth and springtime, therefore appropriate to this month.

April connected with Latin 'aperio' to open, and so referring to the opening of the flowers.

May from Maia, the goddess of growth and increase.

June is said to be from the Roman family Junius, but no one has any idea why they gave their name to a month.

July after Julius Cæsar.

August after Augustus Cæsar.

September to December, the seventh, eighth, ninth, and tenth months of the Roman year when it began in

March, and so-called from the numbers septem, octo, novem, decem.

The idea of giving their names to months was emulated by other Roman Emperors. Nero, for instance, renamed April as Neronius; considering his character we may feel glad that these attempts failed and the older names were adhered to.

The need for international uniformity, and that names are not necessarily inferior to numbers, is shown by the fact that a letter from America dated, for instance, 10/11/49 might have arrived in England in October, 1949, because the writer meant the 10th month, the 11th day, and not as the receiver of the letter thought the 10th day of the 11th month.

Distinguishing the Years

Primitive people are generally quite unable to tell their age, or say how long ago things happened except those just past. A record of the passage of years (as in Fig. 7) by notches is still made by some Indian tribes, but if any trustworthy record of the past or plans for the future are to be made, some way of distinguishing one year from another is needed.

Some of the North American Indians have been found to keep records on animal skins (Plates XI and XII), with a picture to show the chief event of each winter, which gave its name to that year 'People-were-burnt winter' (a bad prairie fire), 'Saw-a-white-woman winter' (the first one ever seen). The ancient Egyptians and Babylonians used the same plan, but a Babylonian inscription recording, for instance, that something occurred in 'the year in which Hammurabi the King with the assistance of Anu and Enlil, marching at the head of his

troops, brought under his power the land of Yamutbal and its king Rim-Sin', apart from its length, is no use to anyone not familiar with their history.

A better plan was to call each year by the length of time the king had reigned, as in the Bible—'In the tenth year of King Uzziah' and so on. In Assyria from 1746 B.C., what seems to us a very curious plan was worked out; after a king came to the throne, a year was called by his name, the next by his chief minister, and so on through other officials and rulers of provinces as long as the king reigned. It is as if 1953 had been called Elizabeth II, 1954 Churchill, 1955 Attlee, and so on. By the end of a reign as long as Queen Victoria's, quite humble individuals must have had the honour of giving their names to a year.

Dating by the years of the kings' reigns was the custom in England in the Middle Ages. This is still used in referring to laws, and till recently the date on most of our more valuable coins was put like that, that is, instead of 1887, they would be dated ANNO REGNI QUINQUAGESIMA (in the fiftieth year of the queen's reign). But this method is confusing because one has to know on what day of the year the king came to the throne, and part of a calendar year will be counted in one year of his reign and part in another. For instance, King George VI came to the throne on December 11th, 1936, so a law passed on December 1st, 1950, will be dated 'the fourteenth year of his reign', but one passed on December 21st, 1950, will be dated 'the fifteenth year of his reign'.

The best plan of all is to number the years from some definite beginning. Romans dated their years from the supposed building of the city; Islam dates everything from the flight of Muhammad from Mecca. During the

Fascist rule in Italy, the years were dated from 1922, when Mussolini came into power, and he would have said that war broke out in the year 17 instead of 1939.

The use of Christ's supposed birth was suggested by a monk called Dionysius Exiguus in A.D. 552 and was adopted by the Venerable Bede in his *Church History of the English Race* written in A.D. 725 and gradually became common in Christian countries. The first authentic English document dated by this method is a charter of King Eadred dated A.D. 948 in Roman numerals.

According to the usage of historians, A.D. 1 is the year that began shortly after Christ was born, and the year before, in which he was born, is known as 1 B.C., though this sounds odd. But astronomers who, to be more logical, inserted a year A.D. 0, only caused considerable confusion in their dating, for instance, of ancient eclipses. Scholars now question the accuracy of the evidence from which Dionysius calculated the date of Christ's birth, and most of them think that it took place three years earlier, that is, in 4 B.C. But we are not likely to change the numbering of the years, for there is no practical gain in the change to offset the confusion it would create.

That dates are not merely for use in history but that each of us owes a debt to Dionysius and others, will perhaps be brought home by contrasting a Tudor dating with our own. It is the date of the oldest diary of English travel and is given as 'ffryst the ffryday afor mydlent, that was Seynt Cuthberdy's Day, and the XX day of Marche, in the VII yer of King Herri the VIIIth and the yer of ower Lorde God MCCCCXVII'—contrast this with 31.3.1518—the same day in modern English notation (by the Gregorian calendar and allowing for the change in New Year's Day).

Chapter V

THE FUTURE OF THE CALENDAR

THE Gregorian calendar has gradually extended its sphere of use. Japan adopted it in 1873, China in 1912, Russia in 1918, Turkey in 1927. India on the other hand still uses fourteen other calendars in addition to the Gregorian, Muhammadan, and Jewish, and the Government prints annually an almanac of 3,273 pages, and this covers only the most important of them!

What a boon a universal calendar would be. But is our calendar, widely used though it is, fitted for such a post of honour? For keeping step with the sun, the answer might be 'Yes', but what about its convenience in everyday life?

War rationing made evident its shortcomings very clearly. A month's rations might have had to last sometimes for twenty-eight, sometimes for thirty-one days if the officials who devised the scheme had not decided to ignore the calendar month and year. Yet this meant that the beginning of a four-week rationing period had no fixed relation to the date of the month, and some shops hung up a rations calendar beside or instead of the usual one.

As another result of the unequal number of days in the months, the 'quarters' have ninety, ninety-one, ninety-two, and ninety-two days if you count from January 1st to March 31st and so on, and if you count from the quarter days used for letting houses, they have ninety, ninety-one, ninety-seven and eighty-seven—scarcely

worth the name. This means that a quarter's rent sometimes gives the right to live in a house for more than a quarter of the year, and sometimes less. For a monthly salary one does not work one-twelfth of the year, and as there are not an even number of weeks in each quarter, thirteen weekly insurance payments do not insure you for three months.

Again, it would save a great deal of trouble if the days of the week fell on the same day of the month in each year. Fixtures now are frequently made for the 'first Thursday' or 'third Saturday' of the month, which is not nearly as satisfactory as a definite date. At present it takes twenty-eight years for the calendar to be repeated exactly, though certain repetitions may come oftener. For instance, 1962, 1973, and 1979 will begin with New Year's Day on Monday like 1951 and have calendars the same, but there will be no year with its calendar the same as 1952 until 1980.

Business people also find it very awkward when the first or last day of a month falls on a Sunday every now and then, for payments due on these days will be paid a day earlier or later, and will probably appear in the accounts of the month next to that to which they rightly belong. Some months have four Sundays or early closing days in them, others have five, so that to compare expenses or profits in one month with another, or with the same month in the year before, is very difficult.

Lastly, the varying date of Easter gives trouble to many people besides holidaymakers. If Easter is early, the transport companies do badly; if Easter is late, there is a slump in the early spring fashions, for people buy summer clothes for Easter instead of spring ones, etc.

So that business men and statisticians who want to

compare one month or year with another have very little good to say of our calendar and would gladly see it altered, if it could be done without too much dislocation and confusion.

The League of Nations, among its many activities, appointed a committee which made extensive enquiries as to what improvements people could suggest, and issued a report in 1926 on the 185 different plans that were sent to it.

The report suggested that our present calendar of months should be scrapped, to be replaced by one of two schemes. The first was that each quarter should contain two months of thirty days and one of thirty-one days, making ninety-one in all, exactly thirteen weeks, in each quarter; the second one was that there should be thirteen months in the year, each twenty-eight days long, so that each of the thirteen months would be exactly four weeks long.

Each of these plans, you will see, only makes a total of 364 days, fifty-two weeks of seven days. But our present leap-year arrangement means 365 or 366 days in the years. So to the fifty-two weeks would be added one day each year and two in leap years, but these would not be counted in any month. They could be public holidays, the annual one could be at the end of the year and the leap-year one added there too to make a longer holiday every fourth year, or it could be put in at the end of June (the half-year). These days would be like, or perhaps instead of, Boxing Day and August Bank Holiday.

A further suggestion is that they should not only not be in any month, but that they should not count as weekdays; they would have to have special names, say,

'Year Day' and 'Leap Day', and they would be quite outside the ordinary succession of weekdays.

The point of this is that if January 1st was a Sunday in the year the new calendar was introduced, there would be fifty-two weeks of seven weekday-names in that year apart from these odd days, so the next year and every year for ever after would begin on a Sunday too, and so would every quarter. And the calendar made for that first year would do for ever. There would be no need to print fresh calendars for each year, and we should soon get to know the calendar from memory and not need one to refer to, as we do so often now.

It might run like this under the twelve-month plan with equal quarters.

	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
January .	1	2	3	4	5	6	7
April .	8	9	10	11	12	13	14
July .	15	16	17	18	19	20	21
October .	22	23	24	25	26	27	28
	29	30	31	—	—	—	—
February .	—	—	—	1	2	3	4
May .	5	6	7	8	9	10	11
August .	12	13	14	15	16	17	18
November .	19	20	21	22	23	24	25
	26	27	28	29	30	—	—
March .	—	—	—	—	—	1	2
June .	3	4	5	6	7	8	9
September .	10	11	12	13	14	15	16
December .	17	18	19	20	21	22	23
	24	25	26	27	28	29	30

'Year Day' every year and 'Leap Day' every fourth year would have to be added somewhere and the calendar is complete. What a saving it would be! Only a three-months calendar to print and remember, and the first of the month always on one of three days (Sunday, Wednesday, or Friday).

The thirteen-month plan, though it seems curious at first sight and has the disadvantage that it is not easy to divide the year into halves or quarters, yet would give us a calendar simpler still. In fact just *one* month would be sufficient. That might be:

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

The year would consist of thirteen months exactly like this, with one and in leap year two extra days added wherever was thought best.

If in addition Easter Sunday were a fixed day in the calendar, with all the other dates that depend on it, our lives would gain enormously in simplicity. The Easter Act of 1928 proposed to place some limit on its wanderings even in our existing calendar and suggested that Easter Sunday should always be 'the first Sunday after the second Saturday in April', but even that is more involved than it need be with a reformed calendar.

The League of Nations Committee came to the conclusion that the time was not ripe and that public opinion needs educating before any reform could be successfully

attempted. Business men already realise the imperfections of the calendar, but prejudices and sentimental objections to change by other people will have to be overcome. The schemes for reform must be made familiar to the coming generation by teachers in schools and by publicity so that they will seem less strange and puzzling to the man in the street. Then, perhaps, it will before long be possible to have an international calendar fulfilling both its functions—accurate agreement with nature and practical utility to man.

CHRONOLOGY

4241 B.C.?	Egyptian calendar of 365 days.
C. 1680 B.C.	Stonehenge built.
716-673 B.C.	Reign of Numa Pompilius—traditional start of Roman calendar of 12 months.
432 B.C.	Metonic cycle proposed.
238 B.C.	Decree passed in Egypt for insertion of leap year.
44 B.C.	Reform of Roman calendar by Julius Cæsar.
A.D. 325	Council of Nicæa—date of Easter fixed.
A.D. 552	Dionysius Exiguus suggested numbering the years from the birth of Christ.
1582	Reform decreed by Pope Gregory XIII.
1752	Gregorian calendar legalised in England.
1884	Greenwich Mean Time used for the standard time zones over the world.

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